BULLETIN OF THE IMPERIAL INSTITUTE

A RECORD OF PROGRESS RELATING TO AGRICULTURAL, MINERAL AND OTHER INDUSTRIES, WITH SPECIAL REFERENCE TO THE UTILISATION OF THE RAW MATERIALS OF THE DOMINIONS, COLONIES AND INDIA

VOL. XXV. 1927

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JOHN MURRAY, ALBEMARLE STREET, W.

ERRATA

Page 88, line 31, for *Journ. Agric Sci* read *Journ. Agric. Res.*
„ 196, lines 14-15, *for* Jansonius *read* Janssonius.
„ 280, line 27, for *Eucalyptus faloata* read *Eucalyptus falcata.*

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BULLETIN OF THE IMPERIAL INSTITUTE

VOL. XXV. 1927

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IMPERIAL INSTITUTE MINERAL RESOURCES DEPARTMENT

It has been decided to discontinue the publication of the Mineral Resources section of the BULLETIN in the form in which it appeared during 1926. This course was recommended to the Governors of the Institute by the Advisory Council on Minerals after due consideration of the amount of time involved in its preparation and the pressing need for continuing the separate publication of monographs on specific subjects.

In future, mineral articles will appear in the BULLETIN only when there is some outstanding and important subject to be dealt with, relating to mineral resources or laboratory investigations. Notices of books will be issued as heretofore, but the regular issue of articles, notes, abstracts, and monthly statistics will be discontinued.

The publication of monthly mineral and metal statistics was commenced in the first quarterly issue of the BULLETIN OF THE IMPERIAL INSTITUTE in 1926, and was continued through the year. The small space now available for statistics in the BULLETIN renders it necessary to discontinue their publication; but the compilation of these monthly statistics will be continued, and they will be available for replies to any enquiries on particular minerals or metals.

Applications for information on the mineral and metal industries will be attended to as heretofore and should be addressed to the Director, Imperial Institute.

THE IMPERIAL INSTITUTE

South Kensington, S.W.7

GENERAL INFORMATION

THE Imperial Institute was founded as the Empire Memorial of the Jubilee of Queen Victoria. Its principal object is to promote the development of the commercial and industrial resources of the Empire.

Under the provisions of the Imperial Institute Act of 1925, the Institute has been reorganised and placed under the control of the Department of Overseas Trade. The Parliamentary Secretary of that Department is the responsible Minister and is Chairman of the Board of Governors. This body consists of the High Commissioners of the Dominions and India, representatives of the Colonial Office and of certain other Government Departments, and the Crown Agents for the Colonies, with additional members representing scientific and commercial interests. The Board has appointed Lieut.-Gen. Sir William Furse, K.C.B., D.S.O., as Director of the Institute.

On July 1, 1925, the Imperial Mineral Resources Bureau was amalgamated with the Imperial Institute, and the fifteen Advisory Technical Committees of the Bureau have been reconstituted in the reorganised Institute.

For the purpose of carrying on the work of the Institute two principal Departments have been established, viz. a Plant and Animal Products Department and a Mineral Resources Department. An Advisory Council for each of these groups of products has been appointed, Sir David Prain, C.M.G., C.I.E., F.R.S., being Chairman of the Plant and Animal Products Council, and Sir Richard

Redmayne, K.C.B., Chairman of the Mineral Resources Council.

A number of Advisory Technical Committees consisting of authorities on the various groups of raw materials co-operate in the work of the Institute, in association with the Advisory Councils, and a close touch is maintained with producers, users, merchants and brokers. Valuable help can thus be given by the Institute to persons interested in the development of the resources of raw materials throughout the Empire.

Intelligence.—The Institute maintains a special service for dealing with enquiries relating to the sources, production, uses and marketing of raw materials and for collecting and disseminating general and statistical information on these subjects. This service is available for the use of individuals and firms, as well as of Government Departments, without charge.

Investigations.—The laboratories of the Institute are specially equipped for the chemical and technical examination of raw materials of all kinds. Full reports are furnished on the composition, uses and value of materials submitted. By its close association with the users of raw materials, the Institute is able to arrange large-scale trials of promising materials when necessary.

Special analyses and investigations are undertaken for firms or private persons in any part of the Empire on payment of appropriate charges. Applications for such investigations should be addressed to the Director.

Investigations on plantation rubber are conducted at the Institute in connection with the Ceylon Rubber Research Scheme.

Library.—The Library of the Institute contains a large collection of Colonial, Indian and other works of reference and is regularly supplied with the more important reports and other publications of government departments in Great Britain, the Dominions, Colonies and India, and most foreign countries. More than 500 serial publications, mainly of a scientific or technical character, are also regularly received.

The library is available (free of charge) for the use of enquirers between the hours of 10 a.m. and 5.30 p.m. on week-days (10 a.m. to 1 p.m. on Saturdays).

Statistical Section.—This section is concerned with the collection of statistics for the use of other Departments of the Institute.

Publications.—The BULLETIN OF THE IMPERIAL INSTITUTE contains records of the principal investigations conducted for the Dominions, Colonies and India at the Imperial Institute, and special articles, notes and abstracts, chiefly relating to progress in tropical agriculture, the development of mineral resources, and the industrial utilisation of all classes of raw materials.

Other publications of the Institute include a series of handbooks dealing with the Commercial Resources of the Tropics, with special reference to West Africa; Reports of the Indian Trade Inquiry; a series of Selected Reports on Investigations at the Institute; Monographs dealing with the Mineral Industry of the British Empire and Foreign Countries as well as a statistical series relating thereto; and a series of volumes on the Mining Laws of the British Empire and Foreign Countries.

Public Exhibition Galleries.—These galleries serve as a permanent exhibition of the natural resources, scenery and life of the people of the Dominions, India, and the Colonies. It is the only exhibition of the kind in London where all the countries of the Empire are represented under one roof. After being closed for re-decoration and for the installation of new heating and lighting systems, the galleries were re-opened to the public on September 29, 1926, the occasion being marked by a reception given to over 1,000 London school teachers who were addressed by Mr. Arthur Michael Samuel, M.P., Parliamentary Secretary to the Department of Overseas Trade, by the Hon. W. G. A. Ormsby-Gore, M.P., Permanent Under Secretary of State for the Colonies, and by the Duchess of Atholl, M.P., Parliamentary Secretary to the Board of Education.

A large number of exhibits, which had deteriorated, as well as show-cases of an obsolete type, have been

withdrawn from the galleries, and a more spacious lay-out has been adopted for the display of exhibits. A special feature has been made of pictorial representation, which takes the form of illuminated dioramas, transparencies and photographs. These are intended to attract the non-technical visitor and children, and to awaken in them an interest in the raw products which are shown in association with the illustrations. Descriptive labels are attached to all exhibits explaining in simple language their origin, occurrence, methods of cultivation or preparation, and uses. To render the galleries of further assistance to teachers in the study of Empire geography and development the exhibits are arranged in a definite sequence on lines suggested by the Advisory Education Committee of the Imperial Institute. Lectures and demonstrations in the galleries are given daily to school teachers and school children by the Guide Lecturers.

At the Central Stand which is maintained in the galleries for enquirers, free literature relating to Empire countries and products is distributed, and priced publications and picture postcards are on sale.

The galleries are open free daily from 10 a.m. to 5 p.m. and on Sunday afternoons from 2.30 to 6 p.m.

Imperial Art Gallery.—As a result of negotiations with the Royal Commissioners for the Exhibition of 1851, the upper east gallery has been set aside for exhibition of the works of selected artists from all parts of the Empire. The gallery is also utilised for judging and exhibiting the work of candidates for scholarships at the British School at Rome. The first main exhibition of Imperial Art will be held in April, May and June this year.

Cinema.—Rapid progress is being made in the construction and installation of a cinema for the display of films illustrating life and industries in the various countries of the Empire. The cinema will be in full operation for the opening of the Imperial Educational Conference in June. Special arrangements are being made for visits of organised parties of school children, to whom the displays will be free.

President of the Association of British Chambers of Commerce	*Sir STANLEY MACHIN, J.P.
Federation of British Industries	A. JOHNSTON.
Royal Botanic Gardens, Kew (Director) . . .	Dr. A. W. HILL, C.M.G., M.A., F.R.S., F.L.S.
Imperial Institute Advisory Councils (Chairmen) . .	*Lt.-Col. Sir DAVID PRAIN, C.M.G., C.I.E., F.R.S., F.R.S.E., F.L.S. (Plant and Animal Products).
	*Sir RICHARD REDMAYNE, K.C.B., M.Sc., M.I.C.E., M.I.M.E., M.I.M.M., F.G.S. (Mineral Resources).
Secretary	Major O. J. F. KEATINGE, D.S.O.

NOTE.—The Director (Lt.-Gen. Sir WILLIAM FURSE, K.C.B., D.S.O.), R. W. MATTHEW, C.M.G., and P. C. RICE, O.B.E., of the Department of Overseas Trade, attend meetings of the Board of Governors and Managing Committee.

Laboratory Committee

Sir FRANK HEATH, K.C.B. (*Chairman*).
Prof. Sir J. B. FARMER, M.A., D.Sc., LL.D., F.R.S.
R. W. MATTHEW, C.M.G.
W. FORSTER BROWN, M.I.C.E., M.I.M.E.
J. A. NELSON, B.Sc.Econ. (*Secretary*).

Publications Committee

P. H. EZECHIEL, C.M.G. (*Chairman*).
P. W. L. ASHLEY, C.B.
E. BARNARD, D.S.O.
H. F. MARRIOTT, A.R.S.M., M.I.M.M., M.I.C.E.
Major O. J. F. KEATINGE, D.S.O. (*Secretary*).

Advisory Education Sub-Committee

Lt.-Gen. Sir WILLIAM FURSE, K.C.B., D.S.O. (Director of the Imperial Institute) (*Chairman*).
Miss C. A. AGUTTER (nominated by the L.C.C.).
E. J. BRENTNALL (nominated by the L.C.C.).
OSCAR BERRY, C.C.F.C.A. (nominated by the London Chamber of Commerce).
P. B. COLES (nominated provisionally by the Board of Education).
F. H. JONES (nominated by the Surrey Educational Committee).
G. H. ORTON (nominated by the Middlesex Education Committee).
W. RANKINE (Chairman of the Association of Day Continuation Schools).
Alderman E. J. SAINSBURY, O.B.E., B.A. (nominated by the National Union of Teachers).
Major O. J. F. KEATINGE, D.S.O. (*Secretary*).

* Members of Managing Committee.

PLANT AND ANIMAL PRODUCTS DEPARTMENT

Advisory Council on Plant and Animal Products

Lt.-Col. Sir DAVID PRAIN, C.M.G., C.I.E., F.R.S. (*Chairman*).
A. CHASTON CHAPMAN, F.R.S., Chairman, Committee on Essential Oils and Resins.
The Rt. Hon. Sir JOSEPH COOK, G.C.M.G., High Commissioner for Australia.
Sir JAMES CURRIE, K.B.E.
Sir EDWARD DAVSON, Bart., nominated by the Secretary of State for the Colonies.
The Hon. Sir GEORGE FAIRBAIRN, Chairman, Committee on Animal Fibres.
Prof. Sir JOHN FARMER, M.A., D.Sc. (Oxon.), LL.D., F.R.S.
Captain VICTOR GORDON, C.M.G., High Commissioner for Newfoundland.
Dr. A. W. HILL, C.M.G., F.R.S., Chairman, Committee on Oils and Oil Seeds.
H. A. F. LINDSAY, C.I.E., C.B.E., nominated by the High Commissioner for India.
H. ERIC MILLER.
Sir EDWARD ROSLING.
H. D. SEARLES-WOOD, F.R.I.B.A., Chairman, Committee on Timbers.
Sir FRANK WARNER, K.B.E., Chairman, Committee on Silk.
ALFRED WIGGLESWORTH, Chairman, Committee on Vegetable Fibres.
A. W. WILSON, nominated by the High Commissioner for Canada.
HAROLD BROWN, Imperial Institute (*Secretary*).

The Chairman of the Advisory Council is *ex-officio* a member of all Committees of the Council.

Advisory Committee on Silk

*Sir FRANK WARNER, K.B.E., Messrs. Warner & Sons, London (*Chairman*).

A. B. BALL, Secretary, Silk Association of Great Britain and Ireland, Incorporated.

*NORTON BRETON, M.B.E. (Milit.), Messrs. Henckell, Du Buisson & Co., London.

Dr. W. S. DENHAM, F.I.C., The British Silk Research Association, Incorporated.

W. H. EVANS, nominated by the Department of Overseas Trade.

FRANK J. FARRELL, M.Sc., Messrs. Grout & Co., Ltd., Great Yarmouth.

*WILLIAM FROST, J.P., Messrs. William Frost & Sons, Ltd., Macclesfield.

W. T. HALL, Messrs. Durant, Bevan & Co., Ltd., London.

Dr. A. D. IMMS, M.A., Institute of Plant Pathology, Rothamsted Experimental Station.

H. A. F. LINDSAY, C.I.E., C.B.E., nominated by the High Commissioner for India.

*J. SUGDEN SMITH, Messrs. John Hind & Co., Ltd., Wyke, Bradford.

*A. JOHN SOLLY, J.P., Messrs. Reade & Co., Ltd., Congleton.

J. H. WATSON, Manchester.

*W. H. WATSON, Messrs. Lister & Co., Ltd., Bradford.

Dr. S. E. CHANDLER, Imperial Institute (*Secretary*).

* Nominated by the Silk Association.

PLANT AND ANIMAL PRODUCTS DEPARTMENT

Advisory Council on Plant and Animal Products

Lt.-Col. Sir DAVID PRAIN, C.M.G., C.I.E., F.R.S. (*Chairman*).
A. CHASTON CHAPMAN, F.R.S., Chairman, Committee on Essential Oils and Resins.
The Rt. Hon. Sir JOSEPH COOK, G.C.M.G., High Commissioner for Australia.
Sir JAMES CURRIE, K.B.E.
Sir EDWARD DAVSON, Bart., nominated by the Secretary of State for the Colonies.
The Hon. Sir GEORGE FAIRBAIRN, Chairman, Committee on Animal Fibres.
Prof. Sir JOHN FARMER, M.A., D.Sc. (Oxon.), LL.D., F.R.S.
Captain VICTOR GORDON, C.M.G., High Commissioner for Newfoundland.
Dr. A. W. HILL, C.M.G., F.R.S., Chairman, Committee on Oils and Oil Seeds.
H. A. F. LINDSAY, C.I.E., C.B.E., nominated by the High Commissioner for India.
H. ERIC MILLER.
Sir EDWARD ROSLING.
H. D. SEARLES-WOOD, F.R.I.B.A., Chairman, Committee on Timbers.
Sir FRANK WARNER, K.B.E., Chairman, Committee on Silk.
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*W. H. WATSON, Messrs. Lister & Co., Ltd., Bradford.

Dr. S. E. CHANDLER, Imperial Institute (*Secretary*).

* Nominated by the Silk Association.

from manufacturers, merchants and others, throughout the Empire. The Bureau has devoted special attention to questions relating to the raw materials required for the industries of the Empire. It has supplied technical information to enquirers, dealing with various problems in connection with the supply and disposal of raw materials of all kinds.

Public Exhibition Galleries.—The collections, illustrative of the present condition and industrial and commercial resources of the Dominions, Colonies and India, are arranged, together with other exhibits, on a geographical system in the public galleries of the Imperial Institute. The galleries are open free to the public, daily (except Sundays, Good Friday and Christmas Day), from 10 a.m. to 5 p.m. in summer, and from 10 a.m. to 4 p.m. in winter.

The following Dominions, Colonies, Protectorates, etc., are represented by Collections, which are in charge of Technical Superintendents:

Canada, Newfoundland; Jamaica, Turks and Caicos Islands, British Honduras, British Guiana, Bahamas, Trinidad and Tobago, Barbados, Windward Islands, Leeward Islands, Bermuda; Falkland Islands; New South Wales, Victoria, Queensland, Tasmania, South Australia, Western Australia, Papua, Northern Territory; New Zealand and Samoa; Fiji, Western Pacific Islands; Union of South Africa, Rhodesia, Nyasaland, St. Helena; Gambia, Sierra Leone, Gold Coast, Nigeria and Cameroons; Kenya Colony, Zanzibar and Pemba; Uganda; Somaliland; Egypt, Sudan; Malta; Cyprus; Ceylon; Hong Kong; Mauritius; Seychelles; Straits Settlements, the Federated Malay States; North Borneo; and the Indian Empire.

Besides the Collections in the Galleries, separate collections of products are maintained for special purposes in the Scientific and Technical Research Department, and for general reference a collection of standard commercial products has been arranged.

Arrangements are made to conduct schools and edu-

cational institutions through the Galleries and to explain the exhibits. Guide-lecturers have been appointed to give demonstrations in the Galleries at stated times.

Courses of instruction in certain specified subjects are given at the Imperial Institute to candidates selected by the Colonial Office for administrative appointments in East and West Africa. Instruction in these Courses in the subject of Tropical Economic Products is given by the staff of the Imperial Institute.

At the Central Stand and Enquiry Office in the main gallery there are available, either for free distribution or for sale, handbooks, pamphlets, circulars, etc., relating to the commerce, agriculture, mining, and other industries of the various countries of the Empire, and also to emigration. The publications of the Imperial Institute are also obtainable. Lists of all these publications are provided.

Library and Map-room.—The library of the Imperial Institute contains a large collection of works of reference, and is regularly supplied with the more important official publications, and with many of the principal newspapers and periodicals of the United Kingdom, the Dominions, the Colonies, India and Foreign Countries. Special attention is given to publications relating to tropical agriculture and forestry, mineral resources, and the production and utilisation of raw materials.

The map-room is provided with a large collection of recent maps of the Dominions, the Colonies and India.

Conference Rooms.—These rooms, on the principal floor, are used for meetings and receptions.

The Cowasjee Jehangier Hall.—The Bhownaggree corridor and rooms in connection with the Cowasjee Jehangier Hall belong to the Indian Section of the Imperial Institute, whilst the Hall is available for lectures, meetings, etc.

Publications

Bulletin of the Imperial Institute.—The Bulletin is published quarterly by Mr. John Murray, 50A, Albemarle Street, London, and may be purchased through any bookseller. It contains records of the principal investigations carried out at the Imperial Institute, and special articles chiefly relating to the industrial utilisation of raw materials and progress in tropical agriculture and production.

Handbooks to the Commercial Resources of the Tropics.—The Secretary of State for the Colonies has authorised the preparation of a series of handbooks dealing with the Commercial Resources of the Tropics, with special reference to West Africa. The handbooks are edited by the Director of the Imperial Institute and published by Mr. John Murray. The volumes already issued, some of which are now in their second edition, are: *The Agricultural and Forest Products of British West Africa*, by Gerald C. Dudgeon, C.B.E., formerly Consulting Agriculturist and Director-General of Agriculture in Egypt, and Inspector of Agriculture for British West Africa; *Cocoa: Its Cultivation and Preparation*, by W. H. Johnson, F.L.S., formerly Director of Agriculture in Southern Nigeria; *Rubber: Its Sources, Cultivation and Preparation*, by Harold Brown, Scientific and Technical Department, Imperial Institute; and *Cotton and other Vegetable Fibres: their Production and Utilisation*, by Ernest Goulding, D.Sc., F.I.C., Scientific and Technical Department, Imperial Institute.

Monographs on Mineral Resources.—The Mineral Resources Committee of the Imperial Institute have arranged for the separate publication of a series of monographs on mineral resources with special reference to the British Empire which at first were published in the Bulletin. These are intended to draw attention to the sources of supply of important minerals within the Empire as compared with those which occur in foreign countries, and to give information respecting commercial uses and value of these

minerals. The following monographs have been published: Zinc Ores, Manganese Ores, Tin Ores, Tungsten Ores, Molybdenum Ores, Chromium Ore, Platinum Metals, Copper Ores, Lead Ores, Mercury Ores, Silver Ores, Coal, Petroleum, Oil Shales, and Potash. Other monographs are in course of preparation, dealing with aluminium, antimony, gold, cobalt, nickel, and vanadium.

Map and Diagrams of Metal Resources.—A new and enlarged edition of this Map and Diagrams, prepared at the Imperial Institute with the advice of the Imperial Institute Committee on Mineral Resources, is now issued. The chief British countries of occurrence and production of the principal minerals are shown on the map. The diagrams give the outputs of these countries in relation to the production of other countries of the world. The metals dealt with are: gold, silver, platinum, copper, tin, lead, zinc, antimony, aluminium, bismuth, iron, manganese, chromium, nickel, tungsten, molybdenum, vanadium, and mercury.

The map and diagrams can be obtained unmounted or mounted on rollers as a wall map.

Mineral Survey Reports.—The following reports on the results of mineral surveys conducted in connection with the Scientific and Technical Department of the Imperial Institute have been published in the Miscellaneous Series of Colonial Reports: *Ceylon* (five reports), 1903–4, 1904–5, 1905–6, 1906–8, 1909–10; *Northern Nigeria* (five reports), 1904–5 (two), 1905–6, 1906–7, 1907–9; *Southern Nigeria* (nine reports), 1903–4 and 1904–5, 1905–6, 1906–7, 1907–8, 1908–9, 1910, 1911, 1912, 1913; *Nyasaland Protectorate* (three reports), 1906–7, 1907–8, 1908–9.

Reports of the Indian Trade Enquiry.—In 1916, the Secretary of State for India requested the Committee for India of the Institute to enquire into and report on the possibilities of extending the industrial and commercial utilisation of the principal Indian raw materials in this country and elsewhere in the Empire. Special

Committees were appointed to deal with the more important groups of Indian materials, to consider the results of investigations and enquiries already conducted at the Imperial Institute, and to obtain the views of leading merchants, manufacturers, and other users of the raw materials of India. A number of reports of these Committees have been published, viz.: *Hides and Skins; Oil Seeds; Rice; Timbers and Paper Materials; Jute and Silk; Lac, Turpentine and Rosin;* and *Cinchona Bark and Myrobalans.* The reports contain important information and recommendations regarding the extension of the industrial and commercial utilisation of Indian raw materials, as well as statements on the general position of each commodity prepared at the Imperial Institute for the use of the Committees.

Selected Reports from the Scientific and Technical Department.—These reports, which are issued in the Miscellaneous Series of Colonial Reports, contain a summary of the results of technical and commercial investigation of certain raw materials conducted in the Scientific and Technical Research Department of the Imperial Institute since 1903. Five of these Selected Reports have been published: Part I. "Fibres" (1909); Part II. "Gums and Resins" (1909); Part III. "Foodstuffs" (1910); Part IV. "Rubber and Gutta Percha" (1912); Part V. "Oilseeds, Oils, Fats and Waxes" (1914). A separate monograph on "Oil Seeds and Feeding Cakes" was published for general information during the war. It deals with the production and utilisation of copra, palm kernels, ground nuts, sesame seed, and mowra seed, and the oils and feeding cakes obtained from them. A collection of earlier reports was printed in a volume of "Technical Reports and Scientific Papers" issued by the Imperial Institute in 1903.

Organisations with Headquarters at the Institute

International Association for Tropical Agriculture, British Section.—The object of this Association, the Central Bureau of which is in Paris, is to promote the scientific

and practical study of all questions connected with tropical agriculture, including the development and utilisation of natural resources, and to arrange for International Congresses. The British Section has its headquarters at the Imperial Institute. Members of the British Section receive the Bulletin of the Imperial Institute and are permitted to use the library and reading-rooms of the Imperial Institute.

Empire Forestry Association.—This Association, which is working in conjunction with the Imperial Institute Advisory Committee on Timbers, has been provided with office accommodation at the Imperial Institute.

Overseas Nursing Association.—An office has been allotted to this Association, the principal object of which is the selection of trained hospital and private nurses for service in the Crown Colonies and Dependencies.

African Society.—This Society has its office at the Imperial Institute.

Northbrook Society.—This Society has been allotted accommodation for a Library and Reading Room in the Indian Section of the Imperial Institute, entered by the East Public Entrance to the Exhibition Galleries and the Bhownaggree Corridor.

CONSTITUTION AND OBJECTS

The Imperial Institute, founded on the initiative of King Edward VII., when Prince of Wales, as the Empire Memorial of the Jubilee of Queen Victoria in 1887, was a united effort of the people of the United Kingdom, of India and of the British countries overseas. From the contributions received from all parts of the Empire the building at South Kensington was erected and a capital sum invested as an Endowment Fund.

The problem remained to provide adequately for the current expenditure needed to make the Institute a centre and clearing house for information and investigation for the commercial development of the natural resources of the Empire and the promotion of inter-Imperial commerce and industry and of other incidental or supplementary objects.

The first Corporation of the Imperial Institute, having been granted a Royal Charter, commenced various activities in order to carry out these purposes. The foundations of the Exhibition Galleries, of an Intelligence Department and a Journal were laid, and subsequently with the aid of additional contributions from public bodies in this country, including the Commissioners of the 1851 Exhibition, and certain of the City Companies, an Investigation Department was initiated and research laboratories provided. The principal operations of the Corporation were, however, devoted to enlisting the financial support and interest of the general public in making the Institute a place of popular resort, and with this intention there was founded in connection with it what was to all intents and purposes a Club in which the usual social facilities were provided in the form of luncheon and dining rooms, concerts and periodical popular exhibitions at a small annual subscription from the Members.

The income thus provided proved, however, to be insufficient to maintain these facilities and also to enable the

principal purposes for which the Institute was founded to be developed.

The Corporation eventually decided to abandon the social side of the Institute, and to transfer to H.M. Government the building, the invested funds and the existing Departments of the Institute's work to be developed for the chief purpose of making known and promoting the utilisation of the resources of the Empire and the other objects referred to in the Royal Charter. Accordingly, in 1900 the building became the property of H.M. Government, by whom the western portion and galleries were leased to the Corporation, the greater part of the eastern and central portions being assigned, subject to certain rights of usage by the Imperial Institute, for occupation by the University of London.

Until the end of 1902 the Imperial Institute was managed by a Governing Body, of which H.R.H. the Prince of Wales (afterwards King Edward VII.) was the first President, who was succeeded by H.M. King George V., when Prince of Wales. There was also an Executive Council, including representatives of India and of the British Colonies and Dependencies. In July 1902 an Act of Parliament was passed transferring the management of the Imperial Institute to the Board of Trade, assisted by an Advisory Committee including representatives of the Dominions, Colonies and India, as well as of the Colonial and India Offices, the Board of Agriculture and the Board of Trade.

In April 1916 the Imperial Institute (Management) Act was passed transferring the property and management of the Imperial Institute to the Secretary of State for the Colonies. The Act provides for the appointment of an Executive Council consisting of twenty-five members, nominated by the Board of Trade, the Secretary of State for India (two each), the Ministry of Agriculture and Fisheries, the Government of India, the Governments of the several Dominions (one each), and the Secretary of State for the Colonies (fourteen). A list of the present members of the Council is given on pp. 24 and 25

and also of the various Committees which have been appointed (pp. 25–30).

Since 1903, the operations of the Institute have been maintained and extended on the lines indicated above, and all its available funds have been devoted to the principal purposes for which the Institute was founded.

The principal work of the Imperial Institute is now chiefly concerned with the development of the commercial and industrial use of the raw materials of the Empire, both at home and in the other parts of the Empire, which are promoted by systematic methods with competent advice and assistance.

The work is chiefly carried on in the three principal departments of the Institute relating to Investigation, Intelligence and Exhibition, the staff of which includes officers with special qualifications in the sciences of chemistry, botany, geology and mineralogy, and in certain branches of technology, in their relation to commerce and to the industrial utilisation of raw materials. Associated with this work are a number of Advisory Committees. Each of the Dominions and India has a Special Committee, including members with knowledge of the trade and industries of these countries. These Committees review the work of the Institute for the countries concerned, and make suggestions regarding it. In addition there are several Technical Committees, including representatives of the trades or industries concerned with the more important groups of raw materials, such as timber, rubber, silk, and minerals, which deal with the results of the work of the Institute on these materials and suggest further subjects for investigation. These Committees also advise as to the steps required to make known the value of a given material to particular trades or industries.

Besides these special Technical Committees, there is also a general Raw Materials Committee, nominated by the Association of British Chambers of Commerce, which includes members of the principal Chambers of Commerce.

This Committee is chiefly concerned in making known to the commercial community, through the Chambers of Commerce, results of investigations conducted at the Imperial Institute which, in the opinion of the Committee, are of importance to trade and industry. This Committee is also the means of suggesting new subjects for investigation.

SCOPE AND ORGANISATION OF WORK

Investigations.—The Scientific and Technical Department is equipped with extensive laboratories and workshops for the investigation of raw materials, including problems relating to the uses for new materials or those concerned with extended uses of known materials. This Department has the advice of the Technical Committees already referred to, and is also in communication with merchants and manufacturers through whom large-scale trials are made of materials which investigations and preliminary trials at the Imperial Institute have indicated are of probable value. The Department is also in communication with scientific and technical institutions at home and elsewhere in the Empire which are in a position to furnish special information or to undertake special technical and scientific research.

The laboratory investigations, etc., conducted at the Imperial Institute are principally concerned with discovering the appropriate use for a particular material, and are usually limited to this purpose. This work involves not only chemical examination of the material but also in many cases small-scale technical trials, followed in promising instances by trials on a practical scale by manufacturers. The Institute also serves a useful purpose in undertaking more purely scientific investigations and researches which cannot be carried out overseas owing to the absence of the requisite staff and equipment and other facilities.

It should also be observed that this Department does

not desire to conduct investigations which can be as well or better conducted by institutions in the countries of origin overseas. It is ready to co-operate in work conducted in institutions in the Dominions, etc., and to undertake such investigations as can with advantage be conducted at the Imperial Institute, or those in which technical trials and special information are required which can best be afforded in communication with manufacturers and others in this country.

This Department is responsible each year for some hundreds of reports relating chiefly to the utilisation of mineral and vegetable raw materials which are made to the Governments of the countries concerned, or to the firms and individuals here and overseas which have requested them.

Intelligence.—A branch of the Scientific and Technical Department, the Technical Information Bureau, has been formed for the double purpose of collecting and issuing information respecting the origin and uses of raw materials. Its business is to collect and critically review published information, and this information is utilised in the current work of the Scientific and Technical Department and also in answering the numerous enquiries which are addressed to the Institute from all parts of the world. This branch also assists in the collection of information which is printed in the quarterly Bulletin of the Imperial Institute, and in the preparation of the other publications issued by the Institute (see pp. 14–16).

Exhibitions.—The Exhibition Galleries of the Imperial Institute, which constitute a permanent exhibition of the present position and chief resources of the countries composing the British Empire, have been recently reorganised, enlarged and extended with special reference to their use for educational and other purposes. The arrangement of the Galleries is geographical, each country having its own sectional space. Not only are the chief raw materials and

industries of each country displayed and explained by descriptive labels, but the Court of each country contains maps, diagrams of production and trade, and photographs of leading cities, towns and scenes of industry and other objects of special interest. Their Majesties the King and Queen have taken great interest in these Collections and have presented many exhibits which are shown in the respective Courts. H.R.H. the Prince of Wales has lent for exhibition the Presents and Addresses received during his visits to Canada, Australasia, India and the East.

This exhibition of the chief resources of each country of the Empire is open to the public without payment, and its value is enhanced by the attachment of a technical staff competent to supply full information regarding these resources, including that relating to their industrial uses.

These Collections are of importance, not only in connection with the work of investigation and intelligence carried out at the Imperial Institute and for commercial purposes, among which is the supply of samples required for trade or industrial trial, but they are also of special importance to the teaching of the commercial geography of the Empire in the public schools and other institutions in this country. In this connection and for the purpose of providing the general information required by the public, Guide Lecturers have been appointed who at stated times explain the nature and significance of the exhibits of each country to parties from schools or of the general public.

It is hoped, with the co-operation of the Dominions and the other countries of the Empire, to maintain and extend these Collections to serve this important public educational purpose, in addition to being a means of attracting attention to the resources of the Empire and the opportunities they present for development.

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The High Commissioner for Newfoundland (The Hon. Sir Edgar Bowring).	The Government of Newfoundland.

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Director of the Imperial Institute

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[In addition to the Committees in which their names are included, the Chairman of the Executive Council and the Director of the Imperial Institute are *ex-officio* Members of all Committees.]

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W. O. R. WYNN, F.I.C.

[1] *Transferred temporarily from Senior Technical Superintendent, Public Exhibition Galleries.*

OPERATIONS OF DEPARTMENTS AND COMMITTEES

The following report gives a general account of the operations of the Institute and a brief description of the more important work of the year 1922 and references to other work of importance concluded in the previous two years. The report is arranged under the following heads: Investigations (Scientific and Technical Research Department); Intelligence (Technical Information Bureau); Technical Advisory Committees; Public Exhibition Galleries; Library and Map-room; and Publications.

The total number of reports, etc., on investigations and enquiries in 1922 was 1,334. Of these, 265 were official and 1,069 unofficial.

The subjects of these reports may be grouped as follows:

Fibres (including Cotton and Silk)	192
Paper-making materials	26
Timbers	63
Oils and Oilseeds	125
Essential Oils	32
Foodstuffs and Fodders	126
Tobacco	19
Rubber, Gutta-percha and Balata	23
Gums and Resins	23
Tanning and Dyeing Materials	20
Drugs and Poisonous Plants	48
Minerals	206
Industrial processes, etc	51
Tropical Agriculture	242
Miscellaneous	138
Total	1,334

INVESTIGATIONS (SCIENTIFIC AND TECHNICAL RESEARCH DEPARTMENT)

The large majority of the investigations at the Imperial Institute are conducted in response to requests for definite information about a raw material, its composition and quality, and usually with regard to the purposes for which a new or little-known raw material can be used, or whether an already-known material can be used for new purposes.

As a rule, in order to answer such questions, laboratory investigation in the first place is necessary to determine composition and quality. This investigation is conducted by experts, who, besides being competent for this work, also have the requisite knowledge and experience to suggest uses to which the material might be applied, and to conduct such preliminary trials as are needed to substantiate the value for the purpose in view, and also later to supply the necessary information to appropriate manufacturers in order that, if need be, a large-scale trial of the material may be made.

The Imperial Institute is the only institution which has a staff specially trained to conduct this class of work, which differs from that conducted at universities or colleges.

If such work is to be successful, the methods must be scientific, but the atmosphere and outlook of the workers must be commercial. Most of this work comes from the countries of production, and in any effort that is to be made to produce a given material on a large scale, it is necessary that the production and quality of that and similar materials in other countries should be known and taken into consideration in any recommendations that may be made.

This knowledge of the places and modes of production and of the quality of the chief raw materials of commerce is possessed by the staff of the Imperial Institute, and is utilised not merely in investigations of the kind described, but also in affording information as to the method of preparing materials for the market, and indicating any defects in preparation shown by samples submitted for report from overseas. In this connection it should be mentioned that besides possessing a staff specially trained and experienced for such work, it is now recognised by enquirers, whether official or unofficial, that the information given and any action suggested by the Institute is disinterested and free from any commercial or financial association with any similar or conflicting interests.

The work as actually carried out is in the hands of groups of skilled workers who do not deal with all raw materials, but are constituted into groups of specialists

in given materials, such as drugs, tanning materials, fibres, timbers, minerals, etc., there being different officers at work on each different group of materials, and engaged not merely in the laboratory work, but in the study of production of such materials throughout the world and of their principal uses.

Such work, if properly organised and restricted to the main purpose in view, is well within the competence of a staff of moderate dimensions, and leaves open a large field for further investigation and research from the more purely scientific standpoint.

It will be convenient in reviewing this important section of the work to deal separately with the principal groups of raw materials, indicating under each subject the countries for which investigations and enquiries have been carried out and giving a few typical illustrations of the work.

The materials are treated in the following order: Minerals; Fibres; Paper-making Materials; Timbers; Oilseeds, Oils and Waxes; Essential Oils (Perfumes, etc.); Foodstuffs and Fodders; Tobacco; Rubber; Gums and Resins; Tanning Materials; Drugs and Poisonous Plants; and Miscellaneous Products.

Minerals

Numerous minerals of various kinds from the following sources were received and reported on: Aden, Australia, British Guiana, Canada, Ceylon, Cyprus, Egypt, Falkland Islands, Fiji, Gambia, Gold Coast, India, Kenya, Malta, Mauritius, Mesopotamia, Newfoundland, New Zealand, Nigeria, Nyasaland, Rhodesia, St. Helena, Seychelles, Sierra Leone, Somaliland, South Africa, Straits Settlements, Uganda, West Indies, Zanzibar.

Brick- and Tile-making Materials.—Considerable interest has been taken recently in East and West Africa in the local production of roofing tiles to take the place of corrugated iron, and of bricks for general building purposes. In this connection a number of clays have been received at the Imperial Institute from Nigeria, Sierra Leone, Uganda, Kenya and Mauritius, and technical trials have been carried out in order to determine the most suitable materials

for use and the best conditions of working. The results have shown that in all cases certain of the clays would be suitable for the manufacture of bricks and tiles, and full reports have been furnished to the Colony concerned, together with specimen bricks and tiles made at the Imperial Institute under the conditions recommended for adoption.

Special interest attaches to the results obtained with diatomite containing a certain proportion of clay, of which there are extensive deposits in Kenya not at present worked. This material furnished strong tiles which are much lighter than ordinary roofing tiles and would therefore be specially useful in many cases. The porosity of these tiles is rather high, but experiments indicated that, in practice, rain would not pass through them to any large extent. It might, however, be found desirable to glaze the upper surfaces, and further trials at the Imperial Institute showed that a satisfactory glaze could be applied to the tiles.

The question as to the best method of improving the quality of bricks and tiles made at Ebute Metta, Nigeria, was referred to the Imperial Institute by the Government, and as the result of technical trials recommendations were made which should lead to the production of bricks and tiles of good quality.

Specimens of clay and sand from Uganda were found to be suitable for the production of roofing tiles of good quality.

Fifteen clays for brick making were received from Sierra Leone, but technical trials showed that only one of them would be suitable for making bricks of satisfactory quality.

A specimen of clay from Mauritius was found on technical trial to be very suitable for the manufacture of strong bricks, whilst a second sample would only furnish soft bricks or " rubbers."

Cement-making Materials.—Owing to the high price of European cement and the cost of its shipment abroad, considerable attention has been given to the possibility of producing cement from materials available locally in certain British Colonies and Protectorates, particularly in Kenya, Nyasaland, Fiji, Nigeria and Ceylon.

Analyses and technical trials made at the Imperial Institute have shown that certain limestones and shales available in quantity in Kenya are well adapted for the production of good-quality Portland cement, whilst other limestones could be burnt at a low cost to give hydraulic lime.

Similar trials with a large number of samples from Nyasaland demonstrated that some of these raw materials were suitable for the production of Portland cement, natural cement and hydraulic lime. In this case cements were made experimentally at the Imperial Institute from the most promising materials and were found to be of good quality.

The examination of a series of limestones and clays from Ceylon has shown that materials suitable for the manufacture of Portland cement exist in quantity in the island.

Under the regulations of the Argentine Government, cement imported into that country must be accompanied by a certificate of quality issued by a laboratory recognised for that purpose by the Government of the country of origin. H.M. Government has appointed the cement-testing laboratory of the Imperial Institute to act as the authority for the issue of certificates in this country.

Kaolins and Pottery Clays.—A number of kaolins and pottery clays have been received from Australia, South Africa and Kenya and submitted to analyses and technical trials at the Imperial Institute. A clay from Bendigo, Victoria, was found to be suitable for the production of white pottery and stoneware, and could also be used for refractory bricks. A clay from South Africa could be utilised for making porous pottery, tiles, sanitary ware and stoneware..

The results of the examination of the clay which occurs below the bauxite deposits in British Guiana showed that it would be suitable for the production of refractory fire-bricks of good quality.

Monazite for Gas Mantles.—The operations of the Mineral Survey of Ceylon (p. 222), which was arranged by the Imperial Institute, led to the discovery in the island of beach deposits of monazite sand and other similar minerals

of value for the manufacture of gas mantles. The sand was investigated at the Imperial Institute and subsequently the Government of Ceylon made arrangements for working the deposits, the necessary plant being selected by the Institute. A number of samples of the concentrated monazite sand produced at the Government works have been examined in connection with the sale of the material in the United Kingdom, which has been arranged in consultation with the Imperial Institute. The results show that Ceylon refined sand is of high grade. Experiments have also been in progress at the Imperial Institute with a view to increasing the proportion of monazite recovered from the crude sand.

The examination of monazite from an unworked deposit in Travancore, Southern India, in comparison with other specimens from the same State, indicated that the percentage of thoria in the monazite from that State may vary considerably with the locality.

Radio-active Minerals.—Pitchblende from Canada has been examined. It is probable that the proportion of the mineral usually present in the deposits will be insufficient to render their exploitation commercially possible.

Titanium Pigment.—The introduction of titanium dioxide as a pigment to replace white lead has caused numerous enquiries to be received as to supplies of ilmenite, the mineral from which the titanium dioxide is extracted. The question of utilising in this connection the ilmenite obtained as a by-product in concentrating monazite sand in Ceylon is under consideration. Sources of ilmenite in Canada and other countries are being investigated, and the iron sand of New Zealand is being examined as a source of titanium.

Fibres

A large number of fibres of various kinds have been received for investigation as to their properties and uses from the following countries, and have been reported on: Australia, Canada, Ceylon, Cyprus, Egypt, Federated Malay States, Gambia, Gold Coast, Hong Kong, India, Kenya, Mesopotamia, New Zealand, Nigeria, North Borneo,

Nyasaland, Rhodesia, St. Helena, Samoa, Seychelles, Sierra Leone, South Africa, Straits Settlements, Sudan, Uganda, West Indies.

Manila Hemp.—A number of consignments of Manila hemp received in this country were found to contain a large proportion of very weak, discoloured fibre, which caused serious loss to rope-makers and shippers, as such fibre is almost valueless for industrial purposes. The Imperial Institute was consulted in this connection by fibre merchants with the request that the causes of the defect should be made the subject of investigation.

The results of a detailed examination of samples of the damaged fibre indicated that they had been affected by a process of fermentation, caused by prolonged storage under moist conditions at a tropical temperature, and this view was confirmed by keeping good Manila hemp for some weeks under similar conditions in the laboratories of the Institute, when it showed similar deterioration. In order to avoid such deterioration in Manila hemp it is evident that greater care should be exercised in the Philippines to ensure that the fibre is thoroughly dry before being stored or baled.

The above conclusions have now received support from the experts of the Philippine Bureau of Agriculture and the Bureau of Science in Washington, who state that large quantities of Manila hemp of the grade which showed the greatest deterioration had been stored in the Philippines under conditions which would be very favourable to bacterial fermentation.

Flax.—The abnormal conditions created by the war occasioned a serious deficiency in the supply of flax from Russia and other European countries, and the Institute has therefore devoted considerable attention to the possibilities of the commercial production of this fibre within the Empire.

In connection with the efforts which are being made in Cyprus to improve the quality of flax produced in the island and to extend the cultivation of the crop, several samples of the fibre have been received at the Imperial Institute for examination and valuation. The flax was of promising quality, but was rather short and had not

been properly scutched. It was pointed out in the report that such flax if better prepared would be readily saleable in the United Kingdom, but that in order to realise good prices the fibre should be of greater length and that efforts should therefore be made to obtain taller plants.

Subsequently three further samples were received which had been much better prepared. One of these, obtained by a special process, had been more satisfactorily scutched than the others and was also somewhat superior to them in strength. In all these cases the fibre was only of about the same length as the earlier specimen, but, in spite of this, such flax if well prepared and scutched would be readily saleable in the United Kingdom at good prices.

Flax from Kenya, Mesopotamia, South Africa and Uganda was also examined.

Sisal Hemp.—The experimental cultivation of Sisal hemp is being carried out in a number of countries and fibre produced in Cyprus, Egypt, Nigeria, Rhodesia, Sierra Leone, and South Africa has been examined at the Institute and reports furnished on its characters and commercial value. In most cases the fibre was of good quality and similar materials would be readily saleable in this country. That received from Sierra Leone was noteworthy on account of its exceptional length.

Samples of fibre and tow from Kenya, where Sisal growing is an important industry, have also been examined and information supplied as to the quality of the different specimens of fibre and as to the type of tow required by spinners in the United Kingdom.

Cotton.—Cotton has been grown in Mesopotamia to some extent from very ancient times and is now cultivated by the Arabs in small quantities along the banks of both the Tigris and Euphrates for local use. Experiments were recently undertaken with a view to introducing a better type of cotton, and a number of forms, including American Upland, Egyptian and selected Indian varieties, have been grown. Samples of the different cottons produced in these experiments were examined at the Imperial Institute and found to be, on the whole, of good quality, the values of

the Egyptian cottons being in advance of those of the corresponding grades grown in Egypt, whilst the American and Indian types were in general well above the "good middling" American grade. All these cottons were greatly superior to that grown by the Arabs. Further samples received from the Director of Agriculture are now under investigation.

It was demonstrated during the German occupation that cotton of good quality can be produced in Tanganyika Territory, and recent investigations of the local conditions have indicated that cotton could be established as the leading economic crop of the country. A series of twenty-six cottons from different districts of Tanganyika, forwarded by the Director of Agriculture, has been examined at the Imperial Institute. Some of them proved to be irregular in strength and length, but it would be possible to improve them by seed selection, and there seems no doubt that if certain of the forms examined were submitted to selection experiments and careful cultivation, a valuable type of cotton could be established well suited to the requirements of the Lancashire market.

Cottons from Australia, Ceylon, Egypt, Gambia, India, Kenya, Nigeria, Nyasaland, Rhodesia, St. Helena, Sierra Leone, Uganda and the West Indies were also examined.

Silk-cottons (Flosses).—In many plants the fruits bear a mass of silky hairs, which in some cases have important industrial applications. Kapok, the most valuable fibre of this class and largely used as a stuffing material in upholstery, is exported mainly from Java. Specimens of the fibre from a number of colonies, including Ceylon, Gambia, Gold Coast, North Borneo, Samoa and Sudan, have been examined at the Institute in order to ascertain their value in comparison with the commercial product. In several cases the kapok examined was of good quality and would be readily saleable in this country if exported in commercial quantity.

Indian kapok, produced by a tree different from that yielding Java kapok, has been fully investigated at the Institute and has been proved to be suitable for use in marine life-saving appliances. As a result of this work the Board of Trade sanctioned the use of Indian kapok for

this purpose under certain conditions in place of Java kapok, which was previously the only kind allowed.

Flosses obtained from several other plants from Egypt, India, Kenya, Rhodesia, South Africa and Uganda have been examined, but these as a rule have proved to be much less valuable than kapok.

Silk.—The principal investigations relating to silk are dealt with in the section on the work of the Silk Production Committee of the Institute (see p. 82). In this connection specimens of silk cocoons from Australia, Egypt, Hong Kong, India, Nigeria and the Sudan have been examined in the laboratories in order to determine the physical characters of the fibre, and have then been submitted to the Committee for their opinion as to the commercial possibilities.

Hat-making Materials.—The Imperial Institute has for some time been investigating the possibility of obtaining within the Empire supplies of raw materials suitable for use by British hat-makers, and a considerable number of samples of straw and plaits have been procured for examination from various countries, including Gambia, Gold Coast, Nigeria, South Africa, Trinidad and Tobago, Grenada, Antigua and Seychelles. Much interest has been taken by the Raw Materials Committee in this enquiry.

Hats and plaits made in Seychelles from various materials which grow in the islands were very favourably reported on by trade experts in Luton and in London, and a trial lot of selected plaits was subsequently obtained for a manufacturer. A small trial order for plait of a particular pattern has also been obtained from Australia and forwarded to the Colony. A conference was also arranged by the Imperial Institute at which the Governor of the Seychelles met representatives of the Luton Chamber of Commerce, and the possible commercial developments were discussed. The question as to whether a market can be created for the Seychelles plaits has been found to depend largely upon whether these can compete with materials available at low prices from other sources, and whether the plaits can be produced in sufficiently large and regular quantities.

Paper-making Materials

Considerable attention has been given at the Imperial Institute to the possible utilisation for paper making of various materials which occur abundantly in different parts of the Empire. Materials from the following countries have been received and reported on: Australia, Bahamas, Ceylon, Egypt, Gambia, Gold Coast, India, Kenya, Mesopotamia, New Zealand, Nigeria, Nyasaland, Rhodesia, St. Helena, Sierra Leone, Tanganyika, Uganda.

Waste Wood.—As the result of a suggestion made by the Imperial Institute to the New Zealand Government that the large quantities of waste wood which are available in the Dominion might be utilised for paper manufacture or other purposes, specimens of eight timbers, including species of beech and pine, were forwarded for investigation. The results showed that all the woods gave satisfactory yields of pulp and that certain of them would be eminently suitable for the manufacture of paper-pulp in New Zealand.

It was pointed out, however, that before the manufacture of pulp from the woods could be undertaken on a commercial scale there are certain factors which would need careful investigation, such as the quantities regularly available, the price at which the waste wood could be delivered at the pulping mill, the selection of a suitable site for the mill and the cost of erecting and equipping the mill, as well as the cost of fuel and chemicals, superintendence and labour. It is understood that these questions are now being investigated in New Zealand by the State Forest Service.

Cotton Stalks.—The possibility of utilising the stalks left after the cotton crop has been harvested has been investigated with Indian samples from the Central Provinces and the Punjab. It was found that the stalks furnish pulp of fair quality, which can be bleached, but that the yields are rather low. The results were sufficiently promising to justify further consideration, and in view of the importance to the cotton-growing industry of the question of the profitable utilisation of this waste material, it has been suggested that large-scale trials should be

carried out, preferably at paper-mills in India, with cotton stalks, both alone and also in admixture with other materials.

Bamboo.—Investigations carried out at the Imperial Institute have shown that the bamboos which cover extensive areas in Kenya Colony furnish paper-pulp of good quality, which can be readily bleached and yields a strong white paper. Arrangements were subsequently made with a firm of paper manufacturers for a practical trial to be carried out at their paper-mill with a consignment of the bamboos. This trial gave very satisfactory results, confirming those of the laboratory investigation.

The Government of the Colony are now prepared to issue licences for the working of two large areas of bamboo forest, one of which is capable of yielding about 40,000 tons of paper pulp annually, whilst the other could furnish about half this quantity.

Neoboutonia Wood.—Another possible paper-making material from Kenya which has been investigated at the Imperial Institute and afterwards submitted to manufacturing trial is the wood of *Neoboutonia macrocalyx*, a tree which is extremely abundant in certain parts of East Africa. The timber, owing to its "woolly" nature, is unsuitable for use in building and joinery, and it was therefore examined in order to determine its suitability for paper-making. The results were satisfactory, but the fibre was rather short, and it was suggested that before recommending the wood for the manufacture of pulp and paper it would be desirable for a large-scale trial to be made at a paper-mill. A consignment of 40 logs, weighing in all about 4½ tons, was subsequently received at the Imperial Institute and arrangements were made with a firm of paper-makers to carry out the trial. The results indicated that owing to the shortness of the ultimate fibres Neoboutonia wood would not be suitable alone for the manufacture of printing paper of good quality and strength, but that the pulp would be useful for mixing with longer-fibred materials. It was suggested that the pulp could be utilised in admixture with pulp from bamboo, as the latter is composed of fibres of about twice the length of those of the Neoboutonia pulp.

Grasses.—There are a number of tall grasses, growing abundantly over large areas in Nigeria, which it was thought might be of value for paper-making. Ten different species of these grasses were accordingly examined at the Imperial Institute to determine their suitability for the manufacture of pulp and paper. On the whole, very satisfactory results were obtained, showing that the grasses give large yields of pulp and that the pulps have good felting properties and are capable of producing strong papers of good quality. The pulps resemble that of esparto grass, but the ultimate fibres are rather shorter. In most cases they bleach easily, and they would all be suitable for the production of good-class writing-papers.

A sample of elephant grass from Nigeria was also examined and gave satisfactory results, the yield of pulp being equal to that given by elephant grass from other sources.

The shipment of these grasses from Nigeria would not be remunerative, but it would be worth while to consider the possibility of utilising them locally for the preparation of paper-pulp for export.

Timbers

A considerable number of timbers have been examined recently from the following countries : British Honduras, Ceylon, Cyprus, India, Kenya, New Zealand, Nigeria, Rhodesia, Sierra Leone.

The work on timbers is carried out in close association with the Timbers Committee, and a number of important investigations are referred to in the section relating to the operations of that Committee (see p. 88). The following account gives a summary of some other investigations on timbers.

Iroko Wood.—The results of the examination at the Imperial Institute of two distinct specimens of Iroko wood from Nigeria showed that there were no marked differences between them in transverse bending strength and compression along the grain, but that in compression across the grain and shearing along the grain one of them gave much better results than the other. The weights per cubic foot also differed considerably.

The figures obtained at the Institute, in conjunction with the corresponding figures recorded for two specimens of Iroko which were examined by the Admiralty, illustrate the extent of the variation in physical strength that may occur in different specimens of this wood.

British Honduras Timbers.—Four timbers from British Honduras were forwarded to the Imperial Institute by the Forestry Officer in the Colony in order that they might be submitted to mechanical tests and their possible uses ascertained. The examination has now been completed and the question of their commercial uses and value is under consideration.

Ceylon Timbers.—Three woods from Ceylon, which were suggested as substitutes for boxwood, were found to be distinctly inferior to true boxwood, but it seemed probable that one of them, " Wira " wood, could be utilised for the production of cheap articles. Further trials were accordingly made with this wood by users of boxwood, and as a result an order has now been obtained from a firm in this country for a trial consignment.

A specimen of true mahogany grown experimentally in Ceylon was of particularly fine quality, although inclined to be " knotty." No difficulty will be experienced in finding a market here for such wood as soon as supplies are available in Ceylon.

Indian Spruce for Matches.—At the request of the Forest Department of the Punjab the Imperial Institute has been considering the possibility of the large forests of Himalayan spruce (*Picea Morinda*) being utilised for match-making. It was suggested by the Forest Department that factories might be established in Northern India with the assistance of British capital and control, or alternatively that the wood or the prepared splints might be exported for match manufacture in other countries.

The results of this enquiry and of practical trials indicate that the spruce compares unfavourably in some respects with the woods used for match-making in this country. It might, however, be possible to utilise the wood for the purpose in India, and this aspect of the question is being further considered. The Indian market

is very extensive, over ten million gross of boxes of matches being imported annually, principally from Japan, which has captured the trade from Sweden and Norway.

Musanga Wood.—Specimens of this wood, which is stated to be abundant throughout West Africa, were forwarded to the Imperial Institute from both Sierra Leone and Nigeria with the suggestion that on account of its lightness it might be suitable for the manufacture of artificial limbs.

The results of experiments at the Imperial Institute indicated that the wood, owing to its short grain, could not be used for artificial limbs, and this conclusion was confirmed by trials by manufacturers and by the Ministry of Pensions. It might, however, be employed for the manufacture of toys and certain small articles, but it is doubtful whether there would be any special demand for Musanga wood in the United Kingdom for such purposes.

The wood appeared more promising as a source of paper, and the results of trials made at the Imperial Institute showed that it could be utilised for this purpose. It would probably not be remunerative to ship the wood to this country for paper-making, but it might be used in West Africa for the manufacture of pulp for export if a mill were established.

Oilseeds, Oils and Waxes

A large number of these products were reported on from the following countries: Australia, Ceylon, Cyprus, Gambia, Gold Coast, India, Kenya, Malta, New Zealand, Nigeria, North Borneo, Rhodesia, South Africa, Sudan, Uganda, West Indies, Zanzibar.

Beeswax.—Some years ago the Imperial Institute drew the attention of the Government of India to statements made by importers in this country that Indian beeswax is extensively adulterated in India (mostly with paraffin wax) and that this procedure constituted a serious menace to the Indian trade. It appeared probable, however, that the constants of genuine unadulterated Indian beeswax had not been properly established, and, at the suggestion of the Imperial Institute, a comprehensive series of authentic waxes (in the form of comb and

not after being melted by native collectors) from different districts and from the different species of bees common in India was collected and forwarded to the Institute for examination. It is evident from the results of the chemical and physical tests that Indian beeswax differs considerably in its constants from the wax from most other countries, and that the tests generally used for detecting the presence of paraffin wax in beeswax are of little value when applied to Indian beeswax. In view of the considerable interest attaching to these investigations a detailed account of the work done at the Imperial Institute has been published in one of the technical journals in order that the information may be available to analysts and others.

Kisidwe Nuts.—These nuts are exhibited in the Public Exhibition Galleries as a product of the Gold Coast. It seemed probable from an inspection of the seeds that they might be of value as a source of oil, and as no record of any previous examination could be found, they were investigated. The dry kernels of the seeds contain about 73 per cent. of a hard, white fat, which could probably be used for edible purposes and in any case could be utilised for soap making. The residual meal has an astringent bitter taste and could therefore not be employed as a feeding stuff. In view of the high percentage of fat, however, the kernels should realise a good price irrespective of the residual meal.

Perilla Seed.—In view of representations made to the Imperial Institute by British manufacturers, through the Raw Materials Committee, as to the desirability of increasing the supplies of drying oils, it was considered that the cultivation of Perilla seed might be advantageously encouraged in British possessions. At present this seed is only produced on a commercial scale in China and Japan, the extraction of oil from the seed being carried on chiefly in Japan. The plant is, however, indigenous in certain districts of India, and the Imperial Institute suggested to the Director of the Botanical Survey of India that its cultivation might be extended with a view to an export trade. As a result of this suggestion samples of Perilla seed produced in the Khasia Hills, the Naga Hills and

Manipur were forwarded for examination. The samples were found to be of good quality and to give satisfactory yields of oil, which is suitable for use in paint and varnish making and for other purposes where a drying oil is required. The value of the seeds and oil depends on the current price of linseed oil.

A supply of Perilla seed was obtained from Japan by the Imperial Institute, and this has been distributed to Kenya, Tanganyika, South Africa, Rhodesia and Cyprus for trial cultivation. These experiments are still in progress. Perilla seed grown experimentally in Cyprus has been received at the Imperial Institute and found to be of good quality.

Kapok Seed.—In connection with an investigation carried out at the Imperial Institute on the commercial value and uses of Indian kapok (*Bombax malabaricum*), it became of interest to ascertain whether the seeds obtained in the preparation of the floss could be utilised as a source of oil as in the case of the true kapok of Java. Examination of seed sent from India at the request of the Institute, indicated that in certain respects the oil is of rather better quality than that obtained from Java kapok seed. The Indian seed, if produced in commercial quantity, should find a ready market in this country at prices equal to or slightly above those realised by ordinary commercial kapok seed.

Seed of an African kapok (*Bombax* sp.) from the Gambia was found to contain a similar oil to that yielded by the Indian kapok seed and would also be readily saleable in this country.

Chinese Wood Oil.—Action has also been taken by the Imperial Institute, on the suggestion of the Raw Materials Committee, to determine whether the trees yielding Chinese wood oil (Tung oil) can be successfully grown in British countries. The oil is at present obtained almost entirely from China, and further supplies would be welcomed by paint and varnish manufacturers. On the recommendation of the Imperial Institute, experiments on the cultivation of the trees are now in progress in India, Ceylon, Malaya, Kenya, Tanganyika and South Africa.

Essential Oils (Perfumes, etc.)

Essential oils, or products yielding such oils, were received from the following countries and were investigated: Australia, Cyprus, Gold Coast, India, Kenya, Seychelles, South Africa, Sudan.

Essential Oils from Seychelles.—During recent years much attention has been devoted in Seychelles to the production of essential oils, and the Imperial Institute has been consulted from time to time regarding the quality and commercial value of the products. The principal Seychelles oils examined recently were patchouli oil, cinnamon-leaf oil, and *Ocimum viride* oil. The patchouli oil was of fairly good quality and resembled the Singapore oil. The cinnamon-leaf oils contained a high percentage of eugenol and compared very favourably with the Ceylon oil. The oil of *Ocimum viride* is of value owing to the presence in it of a large percentage of thymol, and the Imperial Institute has repeatedly pointed out the possibilities offered by this plant for the production of thymol on a commercial scale.

The attention of several essential oil merchants was drawn to these oils by the Institute and the names of those prepared to purchase consignments were forwarded to Seychelles.

Indian Essential Oils.—Thymol, the valuable constituent of Indian ajowan seed, was formerly prepared in Germany from imported seed, but, as the result of action taken by the Imperial Institute during the war, it is now being manufactured in India. The Institute has been able recently to arrange the sale in the United Kingdom of a large consignment of crystalline thymol prepared in Gwalior.

With a view to the development of the essential oil industry in Gwalior, samples of palmarosa, patchouli, lemongrass, clove, fennel and dill oils, representing oils which could be produced on a commercial scale, were forwarded to the Imperial Institute for an opinion as to their quality and market possibilities in the United Kingdom. The oils were well prepared and of excellent quality. Satisfactory arrangements have now been made

through the Imperial Institute with an English firm for the sale of these Gwalior oils.

Western Australian Sandalwood Oil.—Considerable attention has been given at the Imperial Institute to the investigation of the composition and properties of Western Australian sandalwood oil, derived from *Fusanus spicatus.* The possibility of utilising this oil in medicine is limited by the fact that the British Pharmacopœia requires sandalwood oil to be the product of the Indian or true sandalwood tree (*Santalum album*). The investigations carried out at the Imperial Institute have shown, moreover, that the Australian oil differs from the Indian oil in odour, composition and certain physical characters. In therapeutical trials which have been conducted at a London hospital on behalf of the Institute no difference was detected between the action of this oil and that of true sandalwood oil, but it was stated that the demand for sandalwood oil for medicinal purposes is decreasing. The Western Australian oil, however, is quite suitable for use in perfumery and will doubtless find its chief outlet in this direction.

Stirlingia latifolia.—This plant is a native of Western Australia and grows prolifically on the coastal plains. It contains an essential oil which, on examination at the Imperial Institute, was found to consist almost entirely of acetophenone, a substance largely employed as a soap perfume. Commercial enquiry indicates that the oil would be readily saleable in the United Kingdom, provided that supplies could be offered at a satisfactory price.

Vetiver Roots.—Vetiver roots contain an essential oil which is in regular demand for use in perfumery, and recently an enquiry was received from the Gold Coast as to the quality and value of vetiver roots grown in the Colony in comparison with those from other sources. As the result of investigations at the Institute it was found that the Gold Coast roots furnished a high yield of oil, which was of good quality and similar in character to the commercial vetiver oil distilled in Europe. The distillation of this oil, however, is a difficult operation, and it could not be recommended that its preparation should be attempted at present in the Gold Coast. The only alternative is to export the roots.

Foodstuffs and Fodders

Foodstuffs were received for investigation from the following countries: Australia, Ceylon, Cyprus, Gambia, Gold Coast, Hong Kong, India, Kenya, Mesopotamia, New Zealand, Nigeria, North Borneo, Rhodesia, South Africa, Sudan, Tanganyika, Uganda, West Indies.

Burma Beans.—During the last ten years an investigation has been in progress by the Department of Agriculture, Burma, in co-operation with the Imperial Institute, with a view to the improvement of the beans grown in that country. A large number of samples of beans have been examined at the Imperial Institute in the course of the enquiry and an outline of the conclusions arrived at is given below.

The beans most commonly grown in Burma are varieties of *Phaseolus lunatus*, known in this country as red and white Rangoon beans. The former yield minute and usually harmless amounts of prussic acid when ground into meal and mixed with water, whilst under similar conditions the white beans generally yield no prussic acid or only mere traces. The red beans are regarded with some suspicion by agricultural experts in Europe and realise relatively low prices. In order to ascertain whether it is possible to cultivate profitably in Burma varieties of beans more suitable for export to Europe, particularly for human consumption, experiments have been conducted at the Government Farms with Madagascar beans, haricot beans and other kinds, the seed of which was supplied in the first instance by the Imperial Institute. Selected varieties of the local white Rangoon bean have also been grown experimentally. Samples representing several years' crops of all these beans have been forwarded regularly to the Imperial Institute in order to determine the yield of prussic acid and to ascertain whether the introduced forms deteriorate under the conditions obtaining in Burma. The Madagascar beans after seven years' growth exhibit only slight inferiority to the original seed beans and yield negligible amounts of prussic acid. Such beans would be readily saleable in this country at somewhat lower prices than the ordinary Madagascar product. A

small white variety of *P. lunatus* introduced into Burma from the United States has also given promising results. Other Burma beans examined at the Imperial Institute include local races of *P. Mungo*, *P. calcaratus*, *P. vulgaris* and *Canavalia* sp.

Wheat.—A number of investigations have been undertaken in connection with the cultivation of wheat in several countries.

Wheat is being grown experimentally in the Southern Shan States and a number of samples obtained in the course of the trials have been examined at the request of the Director of Agriculture, Northern Circle, Burma, in order to determine their relative value and milling qualities.

The Imperial Institute was also consulted by the Department of Agriculture in Burma as to the possibility of producing white flour from the red macaroni wheat grown at Padu either alone or in admixture with white wheat from the Shan States. A sample of each kind of wheat was forwarded from Burma, and it was found that they differed very little in their chemical composition, but that the character of the glutens varied considerably. Information was supplied by the Imperial Institute as to the milling methods which would be required in order to produce white flour from the red wheat.

The baking qualities of the flour of "Equator" wheat grown in Kenya are under investigation. The bakers in the Colony assert that this flour, if used alone, is not satisfactory for bread-making and an Indian flour is imported to blend with it. It is desired to ascertain whether by the application of suitable methods the Equator flour alone will furnish loaves of the desired quality, and if so, to obtain particulars of the treatment required.

Indian Barley for Malting.—At one time large quantities of barley were sent to this country from India for use in the brewing industry, about two-thirds of the supply coming from Karachi, slightly less than one-third from Calcutta and a small quantity from Bombay.

The attention of the Imperial Institute was drawn to the fact that early shipments of Indian barley germinated well, while the later shipments were liable to contain a large percentage of grains that would not

germinate. It seemed probable that the barley which suffered injury was that which failed to get railed and shipped before the monsoon set in and was consequently stored in cultivators' pits and huts, and that the damage was caused by the humidity and warmth of the rainy season, followed by the drying of the barley before it reached England. As this defect lowered the value of the barley for malting purposes, the matter was referred to the Department of Agriculture, United Provinces, with the suggestion that it should be investigated in India.

Experiments on the influence of atmospheric conditions on the germination of Indian barley have now been carried out by the Government Economic Botanist, United Provinces, and have confirmed the Committee's conclusion. It is considered that, on account of the humidity of North-eastern India during the period of the monsoon, the grain should not be shipped from Calcutta after May, but should be transported from the danger zone towards Karachi or Bombay not later than the end of June.

Tobacco

A large number of tobaccos, received at the Imperial Institute from the following countries, have been examined and reported on: Ceylon, Cyprus, Egypt, Hong Kong, India, Kenya, Mauritius, Nigeria, Nyasaland, South Africa, Tanganyika, West Indies.

Efforts have been made within recent years to produce within the Empire supplies of tobacco to replace at least a portion of the large quantities of leaf imported annually into the United Kingdom from the United States and elsewhere. This object has become of increased interest during the last few years in view of the appreciable tariff preference now accorded to Empire tobacco entering the United Kingdom.

Of all parts of the Empire, Nyasaland has so far been the most successful in the production of "bright" and "semi-bright" leaf capable of replacing American tobacco of this class. The Imperial Institute has been closely associated with the Department of Agriculture in this work from the commencement of the experiments, and is at present carrying out an investigation with a view to deter-

mining the most satisfactory manurial treatment for the crop. In this connection 119 samples of tobacco are now under examination.

The tobacco of Nigeria has also been the subject of investigation at the Imperial Institute, especially in regard to methods of fermentation. In continuation of this work a trial consignment of about 10 cwts. of tobacco, grown partly by the Department of Agriculture and partly by natives, was recently received at the Imperial Institute for sale in the United Kingdom for the purpose of determining its market value.

With regard to cigar tobacco, the Imperial Institute has been associated with the Department of Agriculture, Ceylon, in connection with experiments to determine the varieties of leaf suitable to the local conditions, and has reported on twenty-eight samples. It has been found that so far the characteristics of the Ceylon leaf now grown are more suitable for the Indian and other Eastern markets than for that of the United Kingdom.

The Imperial Institute has assisted the Cyprus authorities in their efforts to improve the quality of the Turkish leaf grown in that country. A large number of samples, representing different varieties of the Turkish type produced in successive years, have been examined and valued.

Samples of Turkish tobacco grown experimentally in Egypt have been investigated, and a report has been furnished regarding the quality of the leaf and the suitability for tobacco cultivation of the various soils on which the experiments were conducted.

Rubber

The most important work on rubber has been carried out in connection with the Ceylon Rubber Research Scheme (see p. 99), the principal object of which is to improve and standardise plantation rubber. In addition, samples were reported on from Australia, India, Nigeria, South Africa, Straits Settlements, Sudan.

Plantations of Para trees have been established in Nigeria, and investigations at the Imperial Institute have shown that the rubber is of good quality and compares favourably with that produced in the East. The Imperial

Institute has examined various samples of Nigerian rubber and advised as to difficulties which have arisen.

Gums and Resins

Gums and resins were received from the following countries: Australia, British Honduras, Cameroons, India, Kenya, New Zealand, Nigeria, Rhodesia, Solomon Islands, South Africa, Straits Settlements, Sudan.

"*Nauli Gum.*"—At the request of the Institute of Science and Industry, Australia, the oleo-resin obtained in the Solomon Islands from a tree known by the natives as "Nauli" has been chemically examined at the Imperial Institute and its possible commercial uses investigated. It is stated that the trees are plentiful and that the yield of the oleo-resin is large.

The material yielded 10 per cent. of oil which might be used as a substitute for aniseed oil; the resin could be utilised for varnish-making. The oil was valued at about half the price of aniseed oil, whilst the resin would have a commercial value equal to that of ordinary rosin of the same colour.

These products might be separated in the Solomon Islands or in Australia and exported. The Institute has suggested that samples should be prepared and forwarded for trials, so that their value can be definitely determined.

Oleo-resin from the Cameroons.—This oleo-resin was investigated in order to determine its composition and possible uses. It was found to be similar in character to the oleo-resins which yield the turpentine and rosin of commerce, and on distillation it furnished turpentine and rosin. The turpentine could be employed in the preparation of paints and varnishes, but its commercial value would probably be somewhat lower than that of American or French turpentine oil. The rosin from the oleo-resin compares favourably in appearance with the best grades of commercial rosin, and furnishes spirit varnishes of promising quality.

Tanning Materials

Tanning materials were received for investigation from the following countries: Ceylon, Cyprus, Fiji, Gambia,

India, Nigeria, Rhodesia, Seychelles, South Africa, Straits Settlements, Sudan, West Indies.

Sant Grains.—The "sant" pods (*Acacia arabica*) of the Sudan contain about 30 per cent. of tannin. Investigations at the Imperial Institute have shown that if the pods are ground and the seeds and fibrous matter removed by sifting, the material thus obtained, known as "sant grains," may contain up to 60 per cent. of tannin. Experiments carried out at the Imperial Institute showed that sant grains are a valuable tanning material, and the Institute endeavoured to develop an export trade with this country by arranging for technical trials of the material by tanners, and later by taking charge of trial shipments to test the market. These measures were successful and about 24 tons of the grains have been disposed of in London. It is estimated that 2,000 tons of sant grains could be produced annually in the Sudan, but in order to develop the industry on a commercial scale it will be necessary to devise a machine capable of preparing the grains from the pods. This question is now receiving the attention of the Imperial Institute in consultation with manufacturers.

Wattle Bark.—As a result of the outbreak of war, a considerable shortage of tanning materials was experienced in this country, owing to supplies from the Continent being cut off, and the Imperial Institute drew the attention of tanners to the wattle bark produced in South Africa, which was then little used here but had been disposed of chiefly in Germany. Wattle bark is now becoming increasingly popular with tanners in this country. In view of the increasing demand for the bark it seemed desirable to investigate the possibilities of growing wattle in other parts of the Empire in order to increase supplies, and enquiries are in progress in India, Ceylon, East Africa, Seychelles and the West Indies. The development of wattle growing in certain countries will depend largely on cheap freights to Europe.

Myrobalans.—No information is available as to whether the different varieties of myrobalans occurring in India vary greatly in the amount of tannin they contain and therefore in their value as tanning agents, although

commercial supplies show considerable differences. This point is of considerable importance as there is a large Indian trade in the material. At the suggestion of the Imperial Institute the Forest Research Institute at Dehra Dun arranged for the collection of authentic samples of the nuts from various localities for investigation at the Imperial Institute. Herbarium specimens of the trees were also collected for botanical identification. As a result of this action by the Imperial Institute thirty-seven samples of myrobalans were received for examination, and the investigation is still in progress.

Drugs and Poisonous Plants

A number of drugs and poisonous plants, received for investigation from the following countries, were reported on: Cyprus, Gold Coast, India, Mesopotamia, Nigeria, Rhodesia, South Africa, Tanganyika, Uganda, West Indies.

Cinchona Bark.—During the war, when there was a serious deficiency in the amount of cinchona bark received from Java, the main source of supply, enquiries were undertaken by the Imperial Institute to ascertain the possibilities of cinchona bark production in other parts of the world. Cinchona barks from St. Helena, the Cameroons and Tanganyika were examined at the Imperial Institute. The bark from the last-named country was of good quality, and at the suggestion of the Imperial Institute a consignment of about three tons was forwarded and disposed of to a firm of quinine manufacturers in this country at a very satisfactory price based on the amount of quinine present. In view of these results it was suggested by the Institute that steps should be taken in Tanganyika to extend the cultivation of cinchona trees.

Datura Leaves.—During the war, communications were received at the Imperial Institute from alkaloid manufacturers regarding sources of supply of suitable material for the production of scopolamine, and enquiries were therefore undertaken in this direction.

At the request of the Imperial Institute the Director of the Botanical Survey of India forwarded a consignment of *Datura fastuosa* leaves for trial, and at a later date a

sample of *Datura Metel* leaves was also received. Both were, however, deficient in the alkaloid required.

Datura Metel leaves received from Montserrat were found to contain satisfactory percentages of the valuable alkaloids scopolamine and hyoscyamine, and manufacturers who were consulted stated that they would be glad to obtain large quantities of the material if it could be produced at a suitable price. Attempts are now being made in Montserrat to establish a trade in this drug.

Datura Metel leaves were also received for examination from South Africa, but were found to be deficient in alkaloids.

Santonin.—In 1921 the price of the drug santonin rose to a very high level, owing to the fact that supplies of wormseed, the flower-heads of *Artemisia maritima,* from which santonin is extracted, had become a virtual monopoly of Russia. The Imperial Institute was therefore approached by manufacturers in the United Kingdom with regard to the possibilities of obtaining Artemisia from other sources. Enquiries were accordingly made as to whether supplies for export could be obtained in Northern India, and samples of the Indian material were requested for examination. The drug which was subsequently forwarded from India proved to be a different species of Artemisia from that furnishing the commercial material, and yielded somewhat less santonin than ordinary wormseed. In view of the high price then prevailing, the manufacturers nevertheless considered that it would be profitable to extract santonin from the material. Further work on this subject is in progress.

Miscellaneous Products

In addition to the materials referred to under separate headings, a number of miscellaneous products were received for report from the following countries: British Guiana, Ceylon, Falkland Islands, Gold Coast, India, Kenya, Mauritius, Sierra Leone, South Africa, Straits Settlements, Sudan, West Indies.

The products of this group included palm nuts for use as vegetable ivory; fish sounds for the manufacture of

isinglass; sponges; yeasts for the production of industrial alcohol from molasses; antelope skins; ash of whale bones for manure; intestinal skins of whales for production of leather or glue; cork substitutes; native basket ware.

INTELLIGENCE (TECHNICAL INFORMATION BUREAU)

The Technical Information Bureau, which is a branch of the Scientific and Technical Department, is responsible for collecting, indexing and arranging such published and other information as is likely to be of service in connection with the work of the Institute, especially technical and commercial information respecting the production, usage and trade in the chief raw materials of the Empire, and so far as possible the position of these subjects in foreign countries. The principal publications are regularly read and indexed, and the records are employed in dealing with enquiries received at the Institute, which are answered by reports from this Branch.

The enquiries are received from Governments, firms and individuals overseas, as well as from manufacturers, merchants and others in this country, and by visitors to the Institute who make verbal enquiry. A large proportion of these enquiries are directly concerned with the production, usage and marketing of the commercial raw materials of the Empire, and may be conveniently classified under headings descriptive of the principal groups of such materials. Another important section relates to requests for technical information regarding the details of industrial processes and manufactures, the methods of tropical agriculture, the processes employed in the preparation of commercial products, and similar subjects. A further section of the work embraces enquiries regarding the prospects for agricultural and other industries in the different countries of the Empire, chiefly in the tropics.

The following is a summarised statement of the more important enquiries dealt with in the Bureau during the last three years, arranged under headings indicating the

subjects concerned and recording the countries to which the enquiries related. Under each head a few examples are given of the nature of the enquiry and of the information supplied.

The work of the Bureau is carried on in close co-operation with the Staff of the Scientific and Technical Department and with that of the Exhibition Galleries, from which the necessary samples of products are obtained. The Bureau is also in communication with companies and firms who are in a position to afford special information, and also with Institutions and Societies concerned with the technical questions raised.

It will be seen that the result of the action has been in many cases to bring into connection different countries which can assist each other in industrial developments, and thus to promote inter-Imperial trade.

Industrial Processes and Manufactures

Enquiries relating to the following countries were dealt with: Australia, Canada, Ceylon, Cyprus, Federated Malay States, Fiji, Gold Coast, India, Kenya, Newfoundland, Nigeria, North Borneo, Nyasaland, Sierra Leone, South Africa, Sudan, United Kingdom.

Production of Power Alcohol.—In connection with the increasing use of alcohol in place of petrol as fuel for internal combustion engines, several enquiries have been received concerning the manufacture of alcohol from various raw materials. As an example may be mentioned an enquiry regarding the possibility of using the sap of the nipa palm for this purpose in the Federated Malay States. This palm has long been known as a source of native beverages, but the systematic utilisation of the plant for the production of alcohol for industrial purposes has not hitherto been seriously considered.

Full information was supplied regarding the growth of the palm, the yields of sugar and alcohol obtainable from it, and other matters relevant to a consideration of its economic possibilities; and suggestions were made regarding the production both of power alcohol and also of sugar from the plant.

Other enquiries related to the production of alcohol

from sweet potatoes. Information was supplied as to the yield of spirit obtainable and references to technical literature dealing with the manufacturing processes involved were furnished. Observations were made regarding the economic aspect of the question. The names of firms in the United Kingdom supplying the machinery necessary for manufacture were also given.

Various materials examined at the Imperial Institute have been supplied to the Fuel Research Board for investigation as possible sources of power alcohol, and the problems involved discussed with officers of the Board.

Starch and Alcohol from Cassava.—Full particulars were supplied to the Director of Agriculture, Gold Coast, regarding machinery and plant required for the manufacture of (1) starch and (2) alcohol from cassava, together with estimates of cost, drawings of plant, etc. Details of the cost of machines and implements suitable for the mechanical cultivation of land with a view to raising cassava on a large scale were also furnished to the Director of Agriculture.

The question was further discussed with the Senior Curator, Agricultural Department, Gold Coast, when on leave in this country, and the addresses of the firms manufacturing the necessary machinery and appliances were supplied to him with a view to his making a selection of the plant required. Subsequently, information was furnished to the Assistant-Director of Agriculture, who visited the Imperial Institute, as to the new Boulard (Mucor) process of fermentation employed in the commercial production of alcohol.

Manufacture of Lime-fruit Products (Citric Acid, etc.).—In connection with a proposal to manufacture lime juice in Lower Burma, a memorandum was furnished to the Deputy Director of Agriculture, Southern Circle, Burma, giving details regarding the processes employed in the manufacture of lime products and the yields of the various products obtained, together with estimates of the cost of equipment of a factory. Recommendations were also made as to the marketing of lime products.

Full information was furnished to the Department of Agriculture, Sierra Leone, as to the cost of the establish-

ment and maintenance of a lime plantation intended for the manufacture of lime products, based on published reports of the cost of similar plantations in the West Indies. Details were also supplied as to the yield of limes and of lime juice. Complete estimates of the cost of the machinery required for the production of lime juice and citric acid were furnished, and the question of the relative commercial advantages of manufacturing concentrated lime juice and citrate of lime was discussed.

Information was also furnished to the Department of Agriculture, Gold Coast, as to the relative prices and demand for lime products in the United Kingdom, and as to plant and equipment suitable for the manufacture of the products.

Tropical Agriculture and Related Enquiries

Enquiries relating to the following countries were dealt with : Australia, British Guiana, British Honduras, Cameroons, Ceylon, Cyprus, Egypt, Federated Malay States, Fiji, Gambia, Gold Coast, India, Kenya, Malta, Mauritius, Nigeria, North Borneo, Nyasaland, Papua, Rhodesia, Sarawak, Seychelles, Sierra Leone, South Africa, Straits Settlements, Sudan, Tanganyika, Uganda, West Indies, Western Pacific, Zanzibar.

A wide variety of subjects dealt with may be grouped under this heading, including methods of tropical agriculture, conditions for special crops, preparation of products for the market, opportunities for planters and settlers, etc. The following may be mentioned as examples :

Coconuts.—Several enquiries relating to coconuts have been dealt with. A Jamaican planter contemplating the cultivation of the early-fruiting " dwarf " or " King " variety of coconut palm, to which much attention has been given in Malaya, was supplied with full particulars as to the origin and advantages of these coconut palms and their cultural requirements. Information was also furnished as to sources whence supplies of the nuts for planting could be obtained. A similar enquiry was received with regard to planting these nuts in St. Lucia.

Information and advice were supplied to a well-known firm of plantation machinery manufacturers with regard

to difficulties experienced by their clients in removing the flesh of the coconut from the shell for the preparation of copra.

Forage Plants in Nyasaland.—A firm of merchants in the United Kingdom received an order for a supply of seeds of leguminous plants to be grown as forage crops in Nyasaland, and also for the seeds of grasses suitable for sowing on the Highlands of that country. The firm in question, being in doubt as to the most suitable varieties of seed for the purpose, sought the assistance of the Imperial Institute. Information was furnished by the Institute as to a number of leguminous and gramineous plants grown for fodder in the tropics and likely to be suitable under conditions prevailing in Nyasaland, with notes on the special values of the various plants and their adaptability to different conditions.

Particulars were also supplied regarding legislation affecting the importation of plants and seeds into Nyasaland.

Rattan Canes.—The large and valuable trade in rattan canes has hitherto depended upon supplies of wild canes cut from the jungle in Malaya, Borneo, Southern China, etc. An important firm of importers in London having a large annual turnover in rattan, which they had hitherto been purchasing from a Chinese producer in Singapore, proposed to grow the canes in plantations in the Federated Malay States, and consulted the Imperial Institute as to the feasibility of their scheme and regarding a number of matters on which they required information. In response, a memorandum was furnished to the firm dealing with the commercial varieties of the cane used for different purposes, their natural habitats and methods of growth, the particular kind of locality and soil to be recommended for forming a plantation, and other matters connected with the different aspects of the proposal.

Machinery for grinding Gutta-percha Leaves.—Hitherto commercial supplies of gutta-percha have been obtained by tapping the trunks of the trees and coagulating the latex obtained.

Considerable quantities of gutta, however, may also be obtained from the leaves of the tree, and in recent years

much attention has been given to the perfection of a process for obtaining gutta on a commercial scale from the leaves of gutta trees specially planted for the purpose. The Forest Research Officer, Federated Malay States, consulted the Imperial Institute as to machinery suitable for grinding the leaves for the subsequent extraction of gutta. Full enquiries were made of firms likely to manufacture suitable machinery, and arrangements were made to carry out trials with leaves resembling gutta leaves in texture and size. Much information regarding suitable machinery was obtained, and the results of the enquiries, together with samples of ground leaves, were forwarded to the Forest Officer with estimates and drawings of selected machines.

Fibres (including Cotton)

Enquiries relating to the following countries were dealt with: Australia, British Guiana, British Honduras, Canada, Ceylon, Egypt, Federated Malay States, Fiji, Gold Coast, India, Kenya, Mesopotamia, Nigeria, North Borneo, Nyasaland, Rhodesia, Seychelles, South Africa, Straits Settlements, Sudan, Tanganyika, Uganda, United Kingdom, West Indies.

Kapok.—Proposals having been made in the Federated Malay States to interest native landholders in the production of kapok, with a view ultimately to developing an export industry, particulars were asked for by the Malay States Information Agency relating to the trade in kapok. Detailed statistics of imports into the chief consuming countries of the world were furnished, together with figures showing the exports from producing countries. Particulars were also supplied regarding the purposes for which kapok is used, and the likely directions in which an extension of the market may be looked for.

Information was also furnished to the Agency, as well as to the Department of Overseas Trade, concerning machinery for cleaning kapok.

Fibre Machinery.—The Imperial Institute was consulted by a firm who were interested in a new machine for the treatment of various fibres. Information was supplied to the firm regarding the production, yields, and

uses of tropical fibres, particularly those of the pineapple and the oil palm.

Roselle Fibre.—Information was supplied to an enquirer regarding the possibility of growing "roselle" for the production of fibre in Johore and Malacca. The bast (stem) fibre of the roselle plant (*Hibiscus Sabdariffa*) has been used in India both for cordage and textile purposes, and proposals have been made for employing the plant on a larger scale as a source of fibre. Particulars were furnished as to the different botanical varieties of the plant, the conditions of soil and climate under which the plant gives the best results and the probable market value of the fibre. A published estimate of the cost of producing roselle fibre was critically considered, particularly with respect to certain items which appeared to err in the direction of optimism.

Silk

Enquiries relating to the following countries were dealt with: India, Kenya, Palestine, Uganda, United Kingdom, West Indies.

Important enquiries on the subject of silk have been referred, as a rule, to the Advisory Committee on Silk Production, and these references have been included in the special report on the work of the Silk Committee (p. 82). A number of questions, however, have been dealt with by the Technical Information Bureau either direct or in consultation with the Silk Committee. The following are examples:

Proposed Cultivation of Silk in Jhalawar.—The question of the possibility of cultivating silk in Jhalawar State, India, having been raised, information was furnished as to the cultivation of the mulberry in Patiala, where silk is grown under conditions similar to those existing in Jhalawar. The State was also put into communication with the Director of Sericulture in Patiala with a view to obtaining expert advice.

Eri Silk in Palestine.—The Imperial Institute was consulted by a firm considering the question of engaging in the export of eri silk from Palestine, who desired information as to the commercial prospects of the silk in this

country. Samples of the cocoons were sent for examination and valuation. The cocoons were of satisfactory quality, and information was given as to their current market value and as to the packing of the cocoons for shipment.

Paper-making Materials

Enquiries relating to the following countries were dealt with : Australia, British Guiana, Canada, Ceylon, Egypt, Gold Coast, India, Kenya, Mauritius, Nigeria, Palestine, Rhodesia, South Africa, Sudan, Uganda, United Kingdom, West Indies.

Manufacture of Paper from Sugar-cane Refuse.—The satisfactory disposal of megasse (the refuse of the sugar-cane produced in large quantities in the manufacture of sugar) is a matter of considerable practical importance. Attempts have been made to utilise the material for the production of paper and a certain degree of success has been achieved.

The Imperial Institute was consulted in connection with proposals to manufacture paper from megasse in British Guiana. A detailed memorandum was furnished dealing with the technology of the subject and the results already obtained in other countries. The economic aspect of the subject was discussed, and the assistance of the Institute was offered in connection with further technical trials.

Elephant-grass in Jamaica.—Elephant-grass has for some time been used in Jamaica as food for stock, and in recent years it has been grown in the island for this purpose. The grass was first introduced into Jamaica as cuttings raised in Cuba from seed obtained from Rhodesia, and it has now increased to such an extent that its use as a paper-making material has been considered.

Advice as to the utilisation of the grass for this purpose was required by a firm in Jamaica. Information was furnished as to the results of trials carried out at the Imperial Institute with elephant-grass from other countries, and advice was given as to the method of treating the grass for the production of " half-stuff," the form in which the material could best be shipped for conversion into paper. Particulars as to the yield of pulp obtainable

from the raw material were supplied, together with references to the technical literature of paper-pulp manufacture.

Baobab.—Information was furnished to an enquirer in South Africa regarding the possibilities of the baobab tree for the manufacture of paper-pulp. Reference was made to the report of the Institute including practical trials carried out with the wood and the bark, from which it was concluded that the inner bark was quite suitable for the purpose, but that the whole bark could not be used.

Particulars were also supplied as to results obtained by foreign investigators.

Timbers (including Forestry)

Enquiries relating to the following countries were dealt with: Australia, British Guiana, British Honduras, Cameroons, Canada, Cyprus, Federated Malay States, Fiji, Gold Coast, India, Kenya, New Zealand, Nigeria, North Borneo, Nyasaland, Seychelles, South Africa, South West Africa, Sudan, United Kingdom, Weihaiwei, West Indies.

Pencil Cedar from Cyprus.—In connection with an enquiry from the Government of Cyprus on the subject of Cyprus pencil cedar, sample slats of the timber were forwarded to the Imperial Institute through the Crown Agents for the Colonies with a request for a report as to the commercial value of the wood and its market prospects in the United Kingdom. Samples were submitted to leading firms of pencil manufacturers and arrangements made for practical trials with the timber. As a result of the trials the manufacturers reported that the timber is not suitable for pencil making. The Crown Agents were informed accordingly, and were furnished with samples of the pencils manufactured from the cedar for transmission to the Cyprus Government in illustration of the report.

Preservation of Railway Sleepers, Jamaica.—At the request of the Colonial Office, information was furnished for transmission to the Governor of Jamaica as to various methods in use for the preservation of railway sleepers. In addition the Imperial Institute offered to arrange for

creosoting trials to be carried out by a leading firm in this country who had offered to interest themselves in the question.

African "Musharage" Wood.—At the request of the Director of Commercial Intelligence Service, Ottawa, the Chief Canadian Government Trade Commissioner in the United Kingdom consulted the Imperial Institute regarding the technical characters of the African timber known as "Musharage." Samples of this timber, from the northern districts of the Union of South Africa, had been submitted to manufacturing firms in Ottawa, as a substitute for Circassian walnut. The firms in question had expressed considerable interest in the wood and desired further information regarding it.

"Musharage" wood (*Olea Hochstetteri*), samples of which are available at the Imperial Institute, belongs to the olive wood class, and is one of the most valuable of the hardwoods of Kenya; it probably also occurs in certain districts of South Africa where the closely related black ironwood (*Olea laurifolia*) is well known.

A memorandum containing full information as to the occurrence, characters and uses of the timber, with particulars of strength tests and the results of practical experience gained with the wood by the Locomotive Department of the Uganda Railway, was prepared and forwarded to the Trade Commissioner. Agents for the sale of the timber, from Kenya, were also mentioned.

British Honduras Woods.—A company operating in British Honduras and desirous of exploiting the timber occurring on their property had been advised that the timber was well suited for the manufacture of bobbins, etc. The company were considering the question of erecting a mill in British Honduras for cutting the "blanks" for export to this country, and before doing so they wished to be put into touch with manufacturers of bobbins and other articles for which the timbers appeared to be adapted. The firm were supplied with the names of manufacturers of bobbins, picking arms, tool handles and golf clubs, and suggestions were made with regard to the special characters required in wood intended for these purposes.

In addition to the foregoing enquiries a number of

questions relating to timbers were dealt with by the Advisory Technical Committee on Timbers (see p. 88).

Oilseeds and Oils

Enquiries relating to the following countries were dealt with: Australia, British Honduras, Canada, Ceylon, Cyprus, Egypt, Federated Malay States, Fiji, Gambia, Gold Coast, India, Kenya, New Zealand, Nigeria, North Borneo, Nyasaland, Palestine, Rhodesia, Seychelles, Sierra Leone, South Africa, Sudan, Tanganyika, Uganda, United Kingdom, West Indies.

Oils in South Africa.—A well-known firm of manufacturing engineers, contemplating the erection of an extensive factory in the Union of South Africa for the treatment of oils for gas production, desired certain information relating to the local production of animal and vegetable oils, etc., as data for consideration in connection with their scheme. Particulars (including full statistical information) on the several points raised by the Company were supplied.

Ground Nuts.—In response to a request from an Association of Planters in South Africa, who proposed to cultivate special grades of ground nuts for export, information was supplied as to purposes for which ground nuts are utilised in this country, together with the names of manufacturing firms likely to be interested in the type of nut proposed to be grown. Information was given regarding the disposal of the nuts in this country, and a statement furnished as to the current prices of the different grades marketed.

Whale Oil.—In connection with a question relating to the whaling industry of Seychelles, information was desired by the Secretary of State for the Colonies regarding the markets for whale oil and other whale products. A number of commercial firms handling the various products were consulted, and information was furnished to the Colonial Office on the market values, uses, methods of marketing, etc., of whale oil, sperm oil, spermaceti wax, whale guano and ambergris.

Soy Beans.—Assistance was afforded to the Deputy Director of Agriculture, Northern Circle, Burma, in connection with proposals to cultivate soy beans in Burma for the European market. Enquiries were made among

commercial firms as to the different varieties of soy bean marketed in this country, and information was furnished to the Deputy Director of Agriculture as to the varieties to be recommended for cultivation in Burma, with particulars as to their different characters.

Parcels of each of the kinds recommended were sent to the Deputy Director of Agriculture, at his request, for the purpose of cultivation trials.

Reference Samples.—A large number of samples of commercial oilseeds and feeding cakes and meals was supplied to the Canadian Department of Agriculture, Ottawa, for official standard reference purposes and as material for micro-analytical work.

Essential Oils (Perfumes, etc.)

Enquiries relating to the following countries were dealt with: Canada, Ceylon, Cyprus, Fiji, Gold Coast, India, Kenya, Mauritius, Rhodesia, Seychelles, Sierra Leone, South Africa, United Kingdom.

Peppermint.—Among the different varieties of peppermint plant, that known as the "Japanese variety" of *Mentha arvensis* has generally been the most highly valued from the point of view of essential oil production, on account of the special qualities of the oil which it yields; but it is practically impossible to obtain the plants of this variety, or its roots or seeds, from Japan on account of export restrictions in that country.

In these circumstances a planter in Rhodesia, who was starting an essential oil distillery, consulted the Imperial Institute. Enquiries were made, as a result of which it was possible to put the planter into touch with a source of supply of the roots of a special variety of the plant which has been shown to yield as large a quantity of menthol as the best Japanese plant.

Information was also furnished to other enquirers in Rhodesia and the Union of South Africa regarding the cultivation of the plant and the distillation of the oil.

Geranium Oil.—Information was supplied to several enquirers in Kenya Colony regarding the cultivation of geranium plants for the production of oil, the best varieties of plant to grow for this purpose, the distillation of the

oil, etc. The names of makers of suitable distilling machinery were furnished in each case.

The Director of Agriculture, Nairobi, was, at his request, furnished with particulars of essential-oil distilling apparatus supplied by British firms, and arrangements were made with the Crown Agents for the Colonies for books dealing with the cultivation of perfume plants to be supplied for the use of the Department of Agriculture.

Seychelles Essential Oils.—Information was supplied to an enquirer desiring to grow essential oil plants in Seychelles regarding essential oils that are already being produced in the islands, with statistics showing the exports of the different oils from the Colony.

Particulars were furnished to another correspondent regarding chemical methods of testing the quality of essential oils produced in Seychelles.

In another case, assistance was given in finding a trade outlet for a consignment of oil of basil produced in Seychelles.

Foodstuffs and Fodders

Enquiries relating to the following countries were dealt with: Australia, British Guiana, Canada, Ceylon, Cyprus, Egypt, Federated Malay States, Fiji, Gold Coast, Hong Kong, India, Kenya, Mauritius, Newfoundland, New Zealand, Nigeria, North Borneo, Nyasaland, Rhodesia, Samoa, Solomon Islands, Somaliland, South Africa, Straits Settlements, Sudan, Tanganyika, Uganda, United Kingdom, West Indies, Zanzibar.

Peas and Beans.—In connection with a proposal to cultivate beans and peas in Tanganyika Territory for export, the Director of Agriculture asked to be supplied with particulars of the bean and pea import trade of London and Marseilles, with special reference to the kinds of products dealt with and the conditions attaching to the import of beans and peas from the tropics. He also desired to be furnished with the names of firms able to supply consignments of the beans and peas concerned for sowing purposes in Tanganyika, together with current prices.

Full enquiries were made as to the position in the bean and pea trade in London and Marseilles, and information

was supplied to the Director of Agriculture as to the varieties in demand in the respective markets, and as to prices, methods of packing, shipment, etc. The addresses of firms willing to supply the seeds for sowing purposes were furnished, together with typical samples and quotations.

Attention was also drawn to literature on the subject.

Dried Fruits.—In connection with the export trade in dried fruits from South Africa, information was desired by the Trade Commissioner for the Union regarding the world's trade in these products. The most important countries producing and exporting dried fruits are Greece, Spain, Turkey, Persia, Mesopotamia, France and California. Information as to the products of these countries, and the trade in them, was collected, and details were furnished to the Trade Commissioner regarding the particular classes of dried fruit produced in each country, the quantities exported and their chief destinations, and the times of year at which the various products reach the London market.

Chicory Manufacture.—In response to an enquiry from the High Commissioner, Union of South Africa, full particulars were supplied regarding the machinery used in the preparation of chicory for the market. The names of manufacturers of appliances for the different processes involved were furnished, together with illustrated catalogues, price lists, and information as to the methods employed. Special enquiries were made in Belgium regarding manufacturers of the chicory-slicing machines employed in that country since the decline of chicory growing in England. The names of manufacturers and full particulars of the machines manufactured by them were obtained and supplied to the High Commissioner. Information was also supplied as regards publications dealing with the cultivation and preparation of chicory.

Tobacco

Enquiries relating to the following countries were dealt with: Canada, Ceylon, Cyprus, India, Kenya, Mauritius, Nigeria, North Borneo, Nyasaland, Rhodesia, South Africa, Uganda, United Kingdom, West Indies.

Production of "Black" Tobacco in Dominica.—An

enquiry was received from a tobacco planter in Dominica regarding the method of preparing a tobacco having the properties required for local consumption by natives. The particular product in question is a dark brown leaf of oily appearance, often known as " black " tobacco. Information was furnished as to the various processes to which tobacco leaf is subjected in order to obtain the appearance and properties required for the Dominica tobacco, and also as to the kind of tobacco leaf best suited for conversion into this class of product.

Machine for Cutting Tobacco in Mauritius.—The advice of the Imperial Institute was sought by the Crown Agents for the Colonies, who had been requested to send out a tobacco-cutting machine for the Government of Mauritius. The machine was required to convert tobacco in the form of " hands " into a product suitable for making cigarettes of the " Caporal " and " Maryland " type. Information was supplied as to the best machines for this purpose, and the firms making them. Advice was also given as to the best size of machine to purchase in view of the output contemplated, and as to the knives with which the machine should be fitted and the question of keeping them in the proper condition.

Manufacture of Cigarettes in India.—Information was desired by an enquirer regarding certain questions connected with proposals to manufacture cigarettes in India. The most important factor is the production in India of tobacco of a kind suitable for cigarettes, a matter which has for some time engaged the attention of the Agricultural Department. Information was supplied as to the results already achieved in this direction and references were furnished to official reports on the subject. The enquirer was also given a list of publications dealing with the technology of the subject, and was furnished with the names of manufacturers of cigarette-making machinery.

Rubber and Balata

Enquiries relating to the following countries were dealt with: British Guiana, Ceylon, Federated Malay States, India, Kenya, Nigeria, Nyasaland, Rhodesia, United Kingdom.

Technical Qualities of Plantation Rubber.—Information was supplied to a firm of telegraph-cable manufacturers regarding the variations in certain properties of plantation rubber (particularly its viscosity and tensile strength) in relation to the age of the tree at the times of tapping.

Utilisation of Rubber Latex.—Recently considerable attention has been given to the possibilities of directly employing rubber latex in different industries. One of the suggestions put forward is that the latex might be used in paper manufacture. Particulars relating to this subject have been supplied to a number of enquirers who have desired information on such points as the classes of paper in which the latex could be used, the proportion of latex to be employed, the effect on the properties of the paper, etc.

Balata.—Information has been supplied regarding the production of balata and the prospects of the industry, including statistics showing its export from the various producing countries in recent years. Enquirers have also been furnished with lists of publications dealing with technical and other aspects of the balata industry.

Gums and Resins

Enquiries relating to the following countries were dealt with: Australia, British Honduras, Canada, India, Kenya, New Zealand, Nigeria, North Borneo, South Africa, Sudan, United Kingdom.

Australian Grass Tree Resin.—The representative in England of a company formed in Western Australia for the purpose of utilising the grass-tree (*Xanthorrhœa*) as a source of "resin" was endeavouring to interest British varnish and polish manufacturers in the utilisation of pure extracted "grass-tree gum" (resin) as a substitute for shellac and rosin.

The assistance of the Imperial Institute in the matter was requested. Details of experiments carried out with the material at the Imperial Institute in the manufacture of (1) lacquer for metals, (2) spirit varnish for wood, and (3) sealing wax were supplied. Subsequently, lacquer and varnish trials were carried out at the Imperial Institute with a sample of purified grass-tree resin ("Acrolac")

supplied by the enquirers. The results of the trials indicated that the material supplied was inferior to shellac for the purposes in view, but that it could be utilised, preferably in admixture with shellac, for certain classes of work.

In reply to a request received from the Department of Overseas Trade for information as regards the market for grass-tree resin in this country and in Europe, particulars were supplied as to the demand for the different grades of the material in England, with information as to their relative market values. Information as to the position of the product in Germany, so far as available, was also supplied.

Considerable attention has been given to the possibility of utilising Xanthorrhœa resins for the manufacture of gramophone records. A large firm of gramophone manufacturers consulted the Imperial Institute as to the different kinds of acaroid (*Xanthorrhœa*) resins imported from Australia, the state of purity in which they may be obtained and the physical and chemical differences between the varieties.

The firm was referred to sources of published information on the questions raised and the names of importers of the resins were supplied.

Shellac.—Information was furnished regarding the chemical composition of shellac, samples of which had been examined at the Imperial Institute, and the laboratory methods used in the investigation of this product. References were furnished to literature dealing with the trade in shellac and also to technical papers on its chemical examination.

Particulars were also supplied to another enquirer regarding the manufacture of synthetic resins and their uses in different industries, with a statement as to the situation regarding the competition of such products with Indian shellac.

Sudan Gums.—At the request of the Government of the Sudan, the Imperial Institute is making enquiries as to the possibility of finding new uses for gum arabic from that country.

Particulars were supplied to an enquirer regarding the

gums produced in the Sudan, more particularly insoluble gums likely to be suitable for manufacturing purposes in place of gum tragacanth. Two such gums, obtained from the trees *Sterculia cinerea* and *Sterculia tomentosa*, were suggested, and a sample of one of them was supplied. Information was furnished regarding their properties, and suggestions were made as to means of obtaining them from the Sudan.

Tanning and Dyeing Materials

Enquiries relating to the following countries were dealt with: Ceylon, Gold Coast, India, Kenya, Nigeria, Palestine, Rhodesia, Seychelles, South Africa, Sudan, United Kingdom, West Indies.

Manufacture of Mangrove Extract in Burma.—An enquirer proposing to engage in the manufacture of mangrove bark extract in Burma consulted the Imperial Institute as to the methods of manufacture as carried out in Borneo, the nature of the machinery employed and the market value of the product.

Full information on the questions raised was supplied to the enquirer, including the names of makers of extraction plant, current prices of the extract and references to literature. The technical character of the extraction process was pointed out to the enquirer, who was also advised to consult the Conservator of Forests in Burma as to the general feasibility of the scheme before embarking on the enterprise.

Wattle Bark.—With the intention of considering the possibility of growing wattle in Palestine for the production of bark and tanning extract, the Zionist Organisation requested the Imperial Institute to supply full information on the subject, including a short history of the wattle-bark industry in Natal and other countries. A statement containing the desired information, including a full bibliography of the subject, references to investigations on the bark carried out at the Imperial Institute and names of manufacturers of extraction machinery, etc., was supplied to the Organisation.

Indian Tanning Barks.—In reply to an enquiry from a large firm of tanners in this country, information was

supplied regarding a number of Indian tanning barks which had been successfully used in India during the war as auxiliary tanning materials, owing to the great demand for the standard tanning barks for war purposes.

Drugs and Poisonous Plants

Enquiries relating to the following countries were dealt with: Australia, Ceylon, Cyprus, Egypt, Federated Malay States, Gold Coast, India, Kenya, Nyasaland, South Africa, Sudan, Tanganyika, United Kingdom, West Indies.

Papain.—Numerous enquiries have been received relating to the production, uses and marketing of papain. Particulars have been supplied regarding the cultivation of the papaw tree, the method of obtaining the juice, the yield obtainable in practice, the preparation and packing of the product, together with statistical and other information relating to the trade in the drug and the factors determining its price. Enquirers have also been furnished with lists of merchants and brokers interested in papain.

This work has necessitated keeping in close touch with the changing conditions of the market; and latterly it has been considered desirable to warn intending producers that there is some risk that in the future supplies may exceed the demand, and to recommend that the production of papain should not be undertaken on a large scale without giving due weight to this risk.

Pyrethrum in Cyprus.—The pyrethrum plant flourishes in Cyprus and attempts have been made in the island to prepare pyrethrum powder from the flowers, but difficulties have been encountered in obtaining a powder of uniform fineness. The assistance of the Imperial Institute was therefore sought by the Director of Agriculture. In response, information was supplied as to the method of preparing pyrethrum powder, and particulars were furnished of machinery offered by firms in the United Kingdom for reducing the flowers to the condition required in the commercial product.

Cultivation of Cinchona in Ceylon.—The question of the increased production of cinchona bark and quinine within the Empire is one that has occupied the attention of the Imperial Institute for some time past. Information was

supplied to an enquirer respecting the prospects of this industry in Ceylon, including the source of supply of the necessary seed.

Pests and Plant Diseases

Enquiries relating to the following countries were dealt with: Canada, Ceylon, Federated Malay States, Gold Coast, India, Kenya, Mesopotamia, Nigeria, South Africa, Uganda, United Kingdom.

White Ants.—During the period under consideration enquiries have been frequently received regarding methods of checking the ravages of white ants attacking buildings, furniture, timber, crops, etc. Typical among such enquiries is one from an important planting company, relating to the damage done by this pest to wooden buildings in Uganda. In response, a memorandum was supplied dealing both with remedies and preventive measures. The results of experience in other countries, where analogous conditions prevail, were summarised and advice based upon them. Information was supplied regarding the treatment of timber to render it resistant to white ants, and as to the use of various preparations for this purpose; and also particulars of apparatus employed for exterminating white ants in cases where they have already established a foothold. Special enquiries were made regarding a method of constructing buildings adopted in Rhodesia with the object of rendering the building, as a whole, proof against attack by the pest. Full particulars of the system, with scale diagrams, were obtained, and copies of these were sent to the firm making the enquiry.

Rats.—Advice as regards combating these serious plantation pests was desired by a firm owning an oil-palm estate in the Federated Malay States. Consideration was given to the conditions on the plantation in question, and suggestions were made for dealing with the vermin. Much information has been collected at the Imperial Institute regarding the use of " viruses " and similar preparations in dealing with rats and mice, and it is considered that, for various reasons, the use of chemical poisons is generally to be preferred. Advice as to the use of certain poisons was given, together with information regarding the asphyxi-

ation of rats by means of gases and the conditions under which this method can be used.

Thrips on Coffee Plantations in Kenya.—Thrips are a well-known insect pest in various countries, and in recent years they have been reported on coffee in East Africa. In response to an enquiry from a coffee planter in Kenya having trouble with this pest, information was supplied as to means of dealing with it, and references to literature on the subject were furnished.

In dealing with matters relating to insect pests frequent communication has been made to the Imperial Bureau of Entomology and technical questions have been referred to that Bureau.

Minerals

Enquiries relating to the following countries were dealt with: Aden, Australia, British Guiana, British Honduras, Canada, Ceylon, Cyprus, Egypt, Falkland Islands, Federated Malay States, Gold Coast, India, Kenya, Mauritius, Mesopotamia, Newfoundland, New Zealand, Nigeria, Nyasaland, Palestine, Rhodesia, St. Helena, South Africa, Sudan, Uganda, United Kingdom, West Indies.

Vanadium Ores.—Information was desired by the Trade Commissioner for the Union of South Africa in response to a cabled enquiry from the Department of Mines and Industries, Pretoria, regarding the market for vanadium ores. These ores are used by makers of ferro-alloys, and the world's output is largely controlled by an American Corporation owning important deposits in Peru. Particulars as to the position were furnished in reply to the enquiry, and information was supplied regarding the consumption of vanadium ores, the factors determining the value of a consignment of ore and other matters relevant to the general question of marketing the South African product.

Sand for Glass-making in India.—An enquiry was received from a firm having interests in India regarding the occurrence in that country of sand suitable for glass-making. The required information was supplied from official sources, as well as particulars regarding the situation of certain glass works in India.

Crystals for Wireless Telegraphy.—Assistance was given to a firm of telephone and telegraph manufacturers desiring to obtain crystals of galena and bornite for use in the construction of wireless apparatus. The firm were furnished with a list of companies producing galena in the United Kingdom and with the name of a firm offering both galena and bornite for the purpose in view.

Miscellaneous Enquiries

A large number of enquiries on various subjects of a general character not readily classified under the preceding headings in this report have also been dealt with. The enquiries have related to the following countries: United Kingdom and Empire generally, Australia, Canada, Ceylon, Egypt, Federated Malay States, Gold Coast, India, Kenya, Mesopotamia, New Zealand, Nigeria, Sierra Leone, South Africa, Straits Settlements, Sudan, Weihaiwei, Zanzibar, etc. etc.

Standardisation of Copra and Cloves, Zanzibar.—In connection with a proposal to introduce legislation in Zanzibar for the standardisation of qualities of copra and cloves in the Protectorate, information was furnished to the Secretariat regarding methods adopted in the principal British countries for controlling and maintaining the quality of exported produce. Recommendations as to grading were also made. The desirability of obtaining the views of merchants and brokers was pointed out and assistance offered in making the necessary enquiries in the United Kingdom.

Pearl Button Industry.—With regard to a proposal to manufacture pearl buttons in Thursday Island, information obtained as a result of special enquiries was furnished to a pearler in the island as to manufacturers of pearl-button machinery, the possibility of obtaining from Great Britain the necessary technical experts in the business and as to rates of wages paid to pearl-button operatives in the home trade.

TECHNICAL ADVISORY COMMITTEES

Several technical committees have been formed in connection with the Imperial Institute which devote special attention to important groups of raw materials. These committees, which meet as required, include representatives of the trades and industries concerned, who in many cases are nominated by bodies interested in the production or utilisation of the various raw materials. The committees advise as to the commercial development of materials which have been examined at the Imperial Institute, and also suggest subjects for investigation and enquiry.

A senior member of the staff acts as secretary to each of the committees, and other officers attend the meetings as required.

The following is a summary of the recent work of the committees.

Raw Materials Committee

The Raw Materials Committee of the Imperial Institute includes representatives of the principal Chambers of Commerce in Great Britain, nominated by the Association of British Chambers of Commerce, and a representative of the Federation of British Industries. A list of the present members of the Committee is given on page 27. The Committee serves as a useful link between the Institute and the Chambers of Commerce in the chief centres of commercial activity throughout the country. Since its appointment in 1916 the Committee has been in close touch with the work of the Imperial Institute on raw materials, and has rendered valuable assistance in promoting the commercial utilisation in the United Kingdom of promising products from overseas.

Reports on the principal raw materials under investigation at the Imperial Institute and questions relating to the economic development of Empire resources are submitted to the Committee for their suggestions as to the best steps to be taken to promote commercial action. Manufacturers on the Committee have also assisted by carrying out technical trials with materials which have been examined at the Institute. In addition the Chambers

of Commerce have co-operated with the work of the Institute by indicating from time to time industries in which difficulty is experienced in obtaining suitable or sufficient supplies of raw materials.

An account of the subjects dealt with at each meeting of the Committee, and of the recommendations made, is circulated to the Association of British Chambers of Commerce, the principal Chambers of Commerce, the Federation of British Industries and the Association of British Chemical Manufacturers, for publication in their journals for the information of those engaged in commerce and industry in this country.

It will be seen that the principal work of the Committee is to assist in finding commercial outlets for raw materials examined at the Imperial Institute, and many of the products referred to in the preceding pages have been brought to their notice. Among matters which have received special attention or have been initiated by the Committee or by Chambers of Commerce, the following may be noted: New hat-making materials from British sources for Luton manufacturers; the production of increased quantities of certain drying oils by cultivation in the Empire of the trees which furnish these oils; the suitability of Empire timbers as substitutes for maple in making boot-lasts; the discovery of a substitute for Sheffield lime for use as a polishing material in the Birmingham metal industry; the industrial use of lac and lac substitutes; the production in this country of synthetic resins; the utilisation of African wild silk; the production of increased supplies of wattle-bark required by British tanners.

Information has also been supplied at the request of several Chambers of Commerce relating to sources of supply of oil seeds, cotton and other fibres, timbers, dye-stuffs, leather, minerals and chemicals which were required by industries in their respective districts.

Silk Production Committee

The Imperial Institute Advisory Committee on Silk Production was appointed in 1916 to consider the question of encouraging the further production of raw silk within

the Empire, and to assist the work of the Imperial Institute on silk.

The Committee includes members representing the leading firms of British silk spinners and manufacturers, nominated by the Silk Association of Great Britain and Ireland, together with other representatives, including the Secretary of the Silk Association and the Director of the British Silk Research Association. The present constitution of the Committee is given on page 29.

The situation confronting the Committee is that the British silk manufacturing industry is dependent, almost exclusively, upon foreign supplies of raw silk. The silk produced within the Empire is relatively small in quantity, and, for the most part, is unsuitable for use in this country, owing chiefly to primitive methods of production. The British silk industry would therefore welcome an increased production, within the Empire, of silk of satisfactory quality for manufacturing purposes.

The Committee have carefully considered the prospects of sericulture in countries of the Empire possessing suitable climatic conditions, and have given special attention to the possibility of developing those silk industries which already exist in British countries, and to the improvement of the technical qualities of the silk produced. Whenever possible, evidence has been taken from overseas technical officers, when on leave in England, as to the local conditions and prospects of sericulture in their respective countries.

An important part of the work of the Committee has been the organisation of practical trials of cocoons and silk obtained from various countries of the Empire, with a view to ascertaining the technical qualities of the material. Many of these trials have been carried out in the works of the members of the Committee.

The Committee have also reported on samples of cocoons and silk sent to the Imperial Institute for examination and report; a number of technical questions have also been referred to the Committee by the Imperial Institute.

The following is a statement of some of the principal investigations already carried out by the Committee, or in progress.

India

The Indian Silk Industry.—India is the most important silk-producing country of the Empire, but the production has greatly decreased and, in general, the quality of the silk is below the standard required for the English market. The Committee have given much attention to the present position of sericulture in India, and to a consideration of measures which should lead to an increased output of silk and to an improvement in quality. A general enquiry into the question was undertaken by the Committee in 1918 in connection with the Indian Trade Enquiry at the Imperial Institute, and a " Report on Indian Silk " was prepared for transmission to the Government of India and published subsequently in the series of Reports of the Indian Trade Enquiry. The Committee recorded their view that it is of the utmost importance to increase the production of a good class of raw silk in India, and expressed the opinion that a radical improvement in the quality and standard of reeling of Indian silk should render it possible for the Indian product to compete successfully with Japanese and Chinese silks. In this connection, the Committee made recommendations for action which they considered would achieve the results desired.

Subsequently, the Government of India was supplied with information regarding the position then obtaining as to the world's supply and consumption of raw silk, and a memorandum on this subject was furnished to the Government of India by the Committee. In acknowledging the memorandum, the Government of India thanked the Committee for the report on Indian silk and assured the Committee that they fully recognised the importance of organising and improving the silk industry in India, and that they proposed to adopt a forward policy as soon as certain preliminary investigations indicated the lines along which progress should be made.

Mysore.—This State formerly exported considerable quantities of silk to the United Kingdom, but the silk is now regarded as generally unsuitable for this market. By arrangements made with the Government of Mysore, the Committee undertook a technical examination of My-

sore silks with a view to the recommendation of measures for the improvement of the silk in order to render it suitable for use in this country. An examination of preliminary samples of silk sent by the Mysore Government showed that Mysore silk is of good quality, but that better reeling is essential. Arrangements were therefore made to carry out reeling trials with Mysore cocoons in modern filatures, and also throwing and weaving experiments in the factories of members of the Committee. The investigations are now practically completed and the results demonstrate that, with modern methods of reeling, Mysore silk is of excellent quality and highly suitable for textile purposes in this country. The final report on the investigations will shortly be available.

Kashmir.—In recent years Kashmir silk has become well known in this market, but users are agreed that there is room for improvement in certain technical qualities. The Committee have discussed with the Director of Sericulture, Kashmir, when on leave in this country, the defects of the silk and the means which should be adopted for its improvement. The most important recommendation of the Committee had reference to the sizes in which the silk should be reeled for this market. Action was taken in Kashmir in accordance with the Committee's recommendations, and it has recently been reported to the Committee that, as a direct result of the adoption of their suggestions, there is already a marked improvement in the sales of Kashmir raw silk in this country.

Arrangements were also made by the Committee for the experimental cultivation in Kashmir of certain European races of silkworms yielding silks much valued by manufacturers. Parcels of eggs were despatched through the Committee to Kashmir with very satisfactory results, and a consignment of the silk obtained is now under investigation in this country.

Cyprus

Next to India, Cyprus is the most important silk-producing country in the Empire. The position of the industry, however, is not satisfactory. No modern filatures exist in the island, and the greater part of the crop

is exported for reeling in France and Italy, where the silk is bulked with material from other sources and its identity as Cyprus silk disappears. The silk, moreover, is lost to the British silk manufacturing industry.

The Committee consider that Cyprus is one of the most promising fields in the Empire for the development of sericulture. A sub-committee was appointed to enquire into the present position of the industry, and to suggest what steps might be taken to place the industry on a basis which would ensure greater profit to the growers and render the silk available for the British market. The question has been fully discussed with the Director of Agriculture when on leave in this country, and the sub-committee's recommendations for the establishment of a filature for the reeling of silk in Cyprus have been submitted to the Cyprus Government.

In the course of the sub-committee's enquiry it was necessary to determine the suitability of Cyprus silk for the needs of the silk trade in the country. As a result of reeling trials carried out on the Continent under the auspices of the Committee, in conjunction with throwing and weaving trials in the works of members of the Committee, it has been shown that Cyprus silk is admirably suited to the needs of the trade.

Sericultural Experiments

From enquiries made by the Committee it appeared that a number of countries of the Empire at present without a silk industry possess climatic and other conditions well adapted to sericulture, and in certain cases the Committee have interviewed the Government entomologists of the countries concerned as to the feasibility of establishing local silk industries. The information obtained was sufficiently encouraging to warrant experimental cultivation of silkworms, and supplies of silkworm eggs of approved varieties have been furnished by members of the Committee and sent to Kenya, Uganda, Rhodesia and Trinidad. Experiments are also being carried out in Jamaica at the instance of the Committee.

Parcels of cocoons obtained from the experiments have already been received from Kenya and Uganda and

submitted to reeling trials on the Continent. The quality of the silk is promising, and further experiments have been recommended.

African Wild Silk

Investigations at the Imperial Institute having shown that silk can be prepared from the nests of the Anaphe wild silkworms occurring in tropical Africa, notably in Uganda and Nigeria, the question has been carefully considered by the Silk Committee, who suggested that the problem of degumming the silk should be further investigated at the Imperial Institute with a view to perfecting a process adapted to commercial purposes. These experiments have been completed and the results published in the Bulletin of the Imperial Institute. Trials of the methods recommended have been carried out by commercial firms with material supplied by the Imperial Institute, and promising results have been obtained. Fabrics woven from the degummed silk have been manufactured by the Chairman of the Committee, and the results show that the silk would be useful for certain purposes if obtainable in quantity at satisfactory prices, and if certain difficulties in treating the fibre can be successfully overcome. Arrangements have recently been made with the Nigerian Government for the supply of a large consignment of nests for further trials on a commercial scale by a firm represented on the Committee.

Australia

The question of sericulture in Australia has also been considered in the light of a report prepared by a member of the Committee when on an official mission in Australia. The enquiry showed that, while climatic conditions in Australia are highly favourable for sericulture, the present conditions of labour render the development of the industry on a commercial scale an impossibility.

Mesopotamia

Parcels of cocoons raised by the Agricultural Department in Mesopotamia have been examined at the Imperial Institute and submitted to the Committee for report.

The cocoons appeared to be of excellent quality, and arrangements were made by the Committee for reeling trials to be carried out on the Continent. The results of the trials confirmed the opinion of the Committee as to the merits of the silk, and a report to the Government of Mesopotamia is in preparation.

Egypt

Hitherto sericulture in Egypt has not progressed, largely on account of competing interests. From information supplied to the Committee, however, it seems possible that production could be considerably increased and that the local establishment of a filature is worth consideration. A memorandum on the general question, containing the Committee's recommendations, has been submitted to the authorities in Egypt.

Other Countries

The Committee has also given advice to official and other bodies, as to the possibilities of sericulture in various countries, including the Union of South Africa, Rhodesia and Hong Kong.

TIMBERS COMMITTEE

The Imperial Institute Advisory Committee on Timbers, appointed in 1916, comprises members nominated by the Royal Institute of British Architects, the Timber Trade Federation of the United Kingdom, the Carpenters' Company, the National Federation of Furniture Manufacturers, the Institute of Builders, the Institute of British Carriage and Automobile Manufacturers, and the Empire Forestry Association. The list of members of the Committee is given on page 30.

The Committee has been considering, in turn, the principal timbers of the overseas countries of the Empire, with a view to bringing a selection of these to the notice of the trade and others in this country, after appropriate tests and trials have been made and precise information obtained as to values and supplies of the timbers selected.

By arrangement, the Committee work in close co-

operation with the Empire Forestry Association (whose offices are at the Imperial Institute), and also with a Committee of the Royal Institute of British Architects.

The following are the principal countries the timbers of which have been or are being considered by the Committee: India, Canada, New Zealand, British Guiana, British Honduras, Nigeria, Gold Coast, Sierra Leone, British North Borneo. The Committee have also dealt with a number of special questions, and advised on matters referred by the Imperial Institute.

Throughout their enquiries the Committee have regularly availed themselves of expert evidence from overseas forestry officers when on leave, and from representatives of the timber trade in this country. Preliminary examination of samples of promising timbers from the Colonial and Indian Collections in the Public Exhibition Galleries of the Institute has been followed by practical trials and strength tests carried out, according to circumstances, at the Imperial Institute or at the works of members of the Committee, on consignments of selected woods obtained from the Governments concerned or from firms interested. Information has also been obtained regarding the prices of the selected timbers, the quantities and sizes regularly available for export, and other necessary commercial information. The final reports on the selected timbers have been sent to the respective Governments and published in the Bulletin of the Imperial Institute, and also (in appropriate cases) in the technical press.

The Committee consider that they have now accumulated sufficient evidence of the existence of many new or little-known Empire timbers worth attention in this country, to warrant the organisation of an exhibition of the timbers in question, accompanied by information as to technical qualities and strength values, prices, quantities available and other commercial particulars. Arrangements have recently been made to incorporate samples of these timbers in a special exhibition of Empire timbers to be arranged at the Imperial Institute in co-operation with the Empire Forestry Association.

The following are examples of some of the more important investigations carried out by the Committee.

British Columbia

Increasing difficulty is experienced in this country in obtaining abundant supplies of softwoods, at satisfactory prices, for general construction purposes. The proportion of such woods imported into this country, derived from Empire sources, is comparatively small. The principal constructional timbers of British Columbia, viz. Douglas fir, Sitka spruce, and Western hemlock were considered by the Committee as well adapted to the needs of consumers in the United Kingdom, and as likely to obtain an established position in this market if brought prominently to the notice of architects, merchants and others. In response to an earlier enquiry from the Agent-General for British Columbia, for information as to British Government specifications for building timbers, the Imperial Institute had suggested that H.M. Office of Works should be consulted by the Imperial Institute as to the inclusion of selected British Columbia woods in the official building specifications of the Department. Action was taken accordingly and arrangements made for H.M. Office of Works to carry out practical trials and tests on consignments of Douglas fir, Western hemlock and spruce—on the understanding that the Office of Works should include the timbers in their official specifications if the results proved satisfactory. The tests and practical trials, in which the Committee took much interest, were carried out over a period of many months on timber supplied by the British Columbia Government to the Imperial Institute. The results proved entirely satisfactory and the three woods mentioned are now included, as agreed, in the building specifications of H.M. Office of Works.

Reports by the Committee on the timbers in question, embodying the results of the investigation, and referring to the inclusion of the woods in the official specifications, were sent to the Agent-General for British Columbia, and to the High Commissioner for transmission to the Government of Canada. The reports were also published in the Bulletin of the Imperial Institute and have been widely reproduced in other journals.

The Committee also made special enquiries regarding a

certain prejudice which hitherto has existed in this country against the use of Canadian Douglas fir. From the evidence obtained, the Committee reported that, in their opinion, the prejudice is in large part unjustified, and that certain defects occurring in the wood could be remedied with improved methods of shipment.

Eastern Canada

A corresponding enquiry into the possibility of increasing the use of Eastern Canadian woods in this country resulted in the recommendation of a number of valuable softwoods and hardwoods whose merits entitle them to a much wider utilisation in the United Kingdom.

One of the principal causes militating against a wider use of Canadian softwoods in the home market is the fact that the timber is not easy to obtain in the range of sizes and forms of manufacture required by the trade. The Committee considered this question in detail and made recommendations as to the sizes chiefly required. The report was communicated to the Canadian Government.

New Zealand

Kauri Pine.—At the suggestion of the Imperial Institute Committee for New Zealand, the Timbers Committee enquired into the possibility of increasing the use of kauri pine in this country. A member of the Committee, whose firm has special experience of the trade in kauri, furnished much information on the subject, and a full report on the trade in the timber, and the uses to which the wood has been or might be put in this country was prepared and sent to the High Commissioner for transmission to the New Zealand Government. The Timbers Committee recorded their view that, on its merits, kauri pine would readily find an extended market in this country, but that the controlling factor is the price of the timber. The Committee also pointed out that the question of the availability of supplies in New Zealand is a factor of the greatest importance.

Beech.—The commercial prospects of New Zealand beech timbers in the United Kingdom have also been

considered at the request of the Committee for New Zealand.

Samples of the timbers from the New Zealand Court in the Exhibition Galleries, and others (supplied by the New Zealand Government and by timber exporters in the Dominion) were examined, and information obtained as to the price of the timbers. The Committee reported that certain of the timbers, notably silver beech, would be suitable in this country for purposes for which imported birch is used, but that the important question is that of price. The report was sent to the Government of New Zealand, through the High Commissioner.

In connection with a further enquiry, New Zealand silver beech was suggested as a substitute for rock-maple for the manufacture of boot-lasts. Large quantities of American rock-maple are used for this purpose and owing to competition from other industries supplies had become scarce and high-priced. By arrangement with a firm in New Zealand a consignment of blocks of silver beech was obtained for practical trials by last makers in Northampton. The timber proved to be very serviceable for boot-lasts, but not fully equal to rock-maple for the purpose. Sample lasts made from the blocks were sent to the firm supplying the latter, with suggestions as to the local uses for the wood.

British Guiana

In connection with the question of marketing selected British Guiana timbers in this country, the Committee, at the invitation of the Colonial Government, selected from tested specimens shown in the Exhibition Galleries a number of woods of promising character, and suggested that a trial shipment of these should be sent to England to test the market. A firm of timber brokers represented on the Committee undertook the arrangements for bringing the shipment to the notice of the trade.

The British Guiana Government have also sought the opinion of the Committee as to the advisability of carrying out trials in this country with mora and wallaba timbers as railway sleepers, these woods having proved satisfactory for the purpose in the Colony. The Committee

considered the woods to be worth trial for the purpose, and arranged with two British railway companies to lay down a useful number of sleepers of each of the woods in the permanent-ways of the companies. The Committee advised the British Guiana Government accordingly, and the Government, in co-operation with local firms, have now arranged for the sleepers required for the trials to be sent to this country.

British Honduras

In consultation with the Forest Officer of the Colony, the Committee have enquired into the possibility of marketing in this country British Honduras woods other than mahogany, rosewood and cedar, which are already well known. A selection was made of promising timbers, of which four varieties occurring in merchantable quantities and good sizes have now been tested in the Timber Laboratory of the Imperial Institute. Similar samples of the remaining selected timbers were requested from British Honduras, subject to these timbers being available at satisfactory prices and in commercial sizes and quantities. So far, however, it appears that at present the conditions laid down cannot be met.

Special enquiry has been made regarding the commercial possibilities of the British Honduras pine forests as a source of coniferous timber.

Nigeria

Commercial Possibilities of Nigerian Timbers.—By arrangement with the Chief Conservator of Forests, Nigeria, when in this country, the Committee undertook to investigate the commercial possibilities of eleven Nigerian timbers (other than mahogany) suggested by the Chief Conservator as worth consideration for export to the United Kingdom. Representative logs of each of the timbers were received at the Imperial Institute from Nigeria with information as to the prices at which the timbers could be shipped. Comparative seasoning trials (artificial and natural seasoning) were put in hand by the Committee, the processes being carried out at the works of a member of the Committee. The artificial seasoning proved entirely successful

in all cases and the Committee based their report on the planks so treated. The natural seasoning has so far also given satisfactory results.

Of the eleven timbers examined, five were regarded by the Committee as likely to find a market in this country, if available for regular export in satisfactory quantities and at competitive prices. The Committee offered certain suggestions for the consideration of the Colonial Government with a view to encouraging the exploitation of these timbers, and discussed the question with Sir Hugh Clifford, Governor of Nigeria, when in this country, and also with firms engaged in the export timber trade from West Africa.

A complete investigation of the mechanical strengths of the timbers selected by the Committee has recently been completed in the Timber Laboratory of the Imperial Institute, and the results will be communicated to the Nigerian Government.

Practical trials with certain Nigerian timbers have also been carried out by the firms of members of the Committee and by the Imperial Institute. A large double door and window-frames made of Nigerian iroko (West African teak) were constructed and fitted in exposed positions in one of the Stores buildings of the Institute with a view to testing this wood as a substitute for teak. The experiments, which have now been extended over four years, have given entirely satisfactory results and have demonstrated the useful character of the timber for the purposes mentioned.

Ring-shake in Sapele Mahogany.—In co-operation with a West African firm of merchants the Committee have carried out an extended series of observations with a view to ascertaining whether sapele mahogany cut from trees ring-barked before felling would be free from ring-shake, a defect which has been detrimental to the use of the timber in the English market.

Logs cut from a tree ring-barked in 1914 and felled in 1917 were sent by the firm to the Imperial Institute and a series of observations on the boards cut therefrom were made. Artificial seasoning processes were also carried out at the works of a member of the Committee. The

observations suggested that ring-barking may have a useful effect in preventing excessive ring-shake, though probably the method cannot be relied upon entirely to prevent the defect.

Experiments were then carried out with a view to testing the widely-held view that ring-shake occurs only in mature sapele trees. On the recommendation of the Imperial Institute, the Nigerian Government sanctioned the experimental felling of a number of young trees for examination by the Committee. After seasoning in Nigeria the logs were shipped to England and have been kept under observation for about two years. The results show that while young sapele trees are not free from ring-shake the defect is not marked, and is not likely to develop if the logs are kept in the round until sawn.

Mangrove Wood.—The question of the possible utilisation in this country of Nigerian mangrove wood has been considered, supplies of the timber being furnished by the Nigerian Government and by an exporting firm. The enquiries and practical trials conducted by the Committee showed that, while mangrove wood possesses several desirable qualities, its hardness and weight would probably restrict its use in this country mainly to railway sleepers. The Railway Executive Committee were therefore consulted as to the possibility of using the wood on British railways, and particulars of the specifications for sleepers on British railways were supplied to the Nigerian Government.

Arising out of this enquiry, experiments in methods of seasoning the timber were carried out in Nigeria, over an extended period, at the suggestion of the Committee.

India

In connection with the Indian Trade Enquiry of the Imperial Institute, the Timbers Committee prepared a report on Indian timbers suited for use in this country, apart from teak and other Indian woods already established on the market. The report was transmitted to the Government of India and subsequently published in the series of Indian Trade Enquiry reports.

More recently, the Committee have taken evidence

from the Conservator of Forests, Burma, as to Burmese timbers worth trial in this country. Arrangements are being made to obtain samples of the timbers recommended with a view to tests and trials being made at the Imperial Institute on the timbers selected by the Committee.

In view of the opening for additional supplies of oak of good quality in this country, an enquiry is in progress as to the suitability of Indian oaks for the purpose. By arrangement with the Conservator of Forests, Punjab, samples of selected oak timbers are being sent for examination and report by the Committee.

North Borneo

Evidence regarding North Borneo timbers has been taken by the Committee from the Conservator of Forests, and a selection of promising timbers likely to be available has been made. By arrangement with the British North Borneo Company, supplies of these timbers are to be sent to the Imperial Institute for strength tests and practical trials to be carried out in the Timber Laboratory of the Institute.

Practical Trials and Investigations

As mentioned above in the appropriate sections, the Committee have investigated, by means of practical trials, special questions upon which information was required to enable them to arrive at an opinion with regard to the timbers under consideration. These trials have included artificial and natural seasoning, experimental fellings of timber trees, joinery and polishing trials, etc., and, according to circumstances, have been carried out at the works of members of the Committee, or in the country producing the timber, or at the Imperial Institute.

A series of fire-tests of selected timbers, planned with a view to the inclusion of successful woods in the schedules of "fire-proof" timbers published by the London County Council and other authorities, was arranged with the British Fire Prevention Committee, and the necessary test doors, etc., were constructed.

At the suggestion of the Committee an important series of practical trials of Empire timbers selected as promising

for motor-body building is being carried out in co-operation with the Institute of British Carriage and Automobile Manufacturers. The timbers (including varieties from Nigeria, India, North Borneo, British Guiana) were selected by a deputation from the Institute of British Carriage Builders who inspected the collections of timbers in the Exhibition Galleries for the purpose. The trials, which are now practically complete, have been carried out under the supervision of the President of the Institute of British Carriage Builders, who is a member of the Committee.

Other Enquiries

Among other questions dealt with by the Committee may be mentioned references from the Imperial Institute, and from the Empire Forestry Association, requesting assistance in connection with enquiries as to (*a*) methods of seasoning boxwood from the Union of South Africa; (*b*) local timbers suitable for making packing cases for the fruit and dairy industries of Rhodesia; (*c*) identification of timbers used in the construction of enemy aircraft during the war; (*d*) substitutes for rock-maple for manufacturing boot-lasts; (*e*) possible use of mangrove timber for wood paving; (*f*) fire-resisting qualities of timber; (*g*) British substitutes for American basswood used for making bee-keeping appliances; (*h*) the "ozone" process for seasoning oak.

Mineral Resources Committee

The Advisory Committee on Mineral Resources was formed in July 1916, to advise on the work conducted at the Institute on minerals.

The Committee includes representatives of the Admiralty, Board of Trade, the London Chamber of Commerce, and also of the sciences concerned with minerals. The late Lord Rhondda was the first Chairman, and he was succeeded by the late Lord Harcourt. Since Lord Harcourt's death Sir Edmond Slade has acted as Vice-Chairman of the Committee. A list of the present members of the Committee is given on page 28.

Many years previous to the formation of the Committee the Imperial Institute had been engaged in collecting and

disseminating information on mineral resources, particularly those of the British Empire, and had published periodically in its "Bulletin" about forty special articles on the occurrence and uses of various economic minerals. A separate monograph on *The World's Supply of Potash* was published in 1915 and the first edition was soon exhausted. A separate monograph on *Zinc Ores* followed in 1918 and the entire edition was quickly sold. The Committee recommended in its report of 1917 that all the special articles on Mineral Resources hitherto published in the Bulletin should, in future, be extended and issued as separate publications, with special reference to the minerals of the British Empire, and that a *Mineral Year Book* should be issued annually.

After consultations with the recently formed Imperial Mineral Resources Bureau it was arranged in 1919 that, in accordance with the request of the Bureau, that Department should take over the proposed publication of the *Mineral Year Book* which the Committee had intended to issue, and that the monographs should be issued by the Institute as arranged by the Committee. The groundwork of each of these monographs is prepared by a specialist selected by the Committee, who is assisted by the staff of the Imperial Institute and by members of the Committee. It was decided that the name of the chief compiler should be stated on each monograph. The monographs are published for the Institute by Mr. John Murray.

Up to the present the monographs which have been issued are on: Potash (1915), Zinc (1918), Manganese (1919), Tin (1919), Tungsten (1920), Coal (1920), Platinum Metals (1920), Lead (1920), Chromium (1921), Petroleum (1921), Silver (1921), Oil Shales (1921), Potash, 2nd edition (1922), Molybdenum (1922), Mercury (1923), and Copper (1923).

The monographs now in preparation include Aluminium, Antimony, Bismuth, Gold, Nickel, Cobalt, Vanadium, and Zinc (2nd edition).

The production by the staff of the Institute, with the advice and assistance of the Committee, of a Mineral Map, to show the chief occurrences of metallic ores within the British Empire, was completed in 1917. By arrange-

ment with the Admiralty the Map was printed by the Ordnance Survey in 1918. The whole edition was soon exhausted and a second and enlarged edition was issued in 1922, including diagrams illustrating the metal production of the British Empire in relation to that of the world. This enlarged Map was published for the Imperial Institute by Messrs. George Philip and Son, Ltd.

The Committee, in addition to advising as to the mineral publications of the Institute, has also considered a number of questions concerned with investigations of minerals conducted at the Imperial Institute, and the supply of information respecting the occurrence and utilisation of minerals of all kinds. These are dealt with in the section of the report which relates to minerals (p. 207).

RUBBER RESEARCH COMMITTEE

In 1913 a scheme of research for the improvement of plantation rubber was established by the Ceylon Government in co-operation with the Imperial Institute and in conjunction with a number of planting companies in the Colony, the general supervision being vested in Committees in Ceylon and in London. An independent scheme of rubber research was at that time conducted in the Colony by the Rubber Growers' Association. The existence of these two schemes involved some duplication of investigations, and in 1920 arrangements were made for their amalgamation. Under the new scheme, representatives of the Rubber Growers' Association have been added to the Committee appointed by the Government of Ceylon to administer the scheme in the Colony, and also to the London Committee, which advises as to the work carried out at the Imperial Institute. The London Committee includes a representative of the Research Association of British Rubber and Tyre Manufacturers, with whom cooperation has been arranged in dealing with questions relating to raw rubber which require investigation. A list of the members of this Committee is given on page 28.

The funds for carrying on the Scheme are provided by contributions from the Ceylon Government and the Rubber Growers' Association, and by subscriptions from planters

and others connected with the rubber industry in the Colony who are not members of the Rubber Growers' Association. Steps are being taken to obtain the co-operation of the entire planting community in Ceylon.

The Scheme provided for the appointment in Ceylon of a chemist, a mycologist, a physiological botanist, and a secretary and travelling inspector, and at the request of the Ceylon Committee suitable candidates for these posts were selected by the London Committee. All four officers have now commenced duty in the Colony.

The staff for the chemical and vulcanisation investigations at the Imperial Institute includes a superintendent, two assistants and a mechanic.

In connection with the scheme over five hundred samples of rubber were specially prepared in Ceylon for detailed investigation at the Imperial Institute, and reports on a large number of these had been made to Ceylon prior to the revised scheme coming into operation. Reports on the remainder of the samples have since been completed and forwarded to Ceylon, together with a summary of the main conclusions to be drawn from the whole of the experiments conducted since the commencement of rubber research in the Colony. The questions investigated have included: (1) the amount of variation shown by rubbers prepared by a standard method—(*a*) from trees of different ages, (*b*) from different estates, and (*c*) at different seasons of the year; (2) the effect of different methods of preparing the raw rubber, *e.g.* different methods of coagulation; the addition of preservatives to the latex; the dilution of the latex before coagulation; the form of the rubber (sheet, crêpe, block, etc.); various methods of drying, including smoking; the characters of moist rubber, etc.; (3) the cause of the inferior mechanical properties of scrap rubbers; and (4) the suitability of plantation rubber for special manufacturing purposes. Important investigations have also been carried out on the influence of the constituents of raw rubber, other than caoutchouc, on vulcanisation; on methods of testing raw rubber; and on other related problems.

These experiments have furnished valuable results regarding the properties of plantation rubber. A detailed

programme for further work in London, based on the results already obtained, has been drawn up, and series of samples for the investigations it is proposed to carry out are now being prepared in Ceylon.

PUBLIC EXHIBITION GALLERIES

The Exhibition Galleries of the Imperial Institute contain between thirty and forty separate Collections of exhibits illustrating the nature and chief resources of the oversea countries of the Empire. Every country is now represented.

Each year new exhibits are received from private sources as well as from governments for renewals or additions, and the work of rearrangement and relabelling is in continuous operation by the Staff of the Institute. In the last two years important improvements and many additions of new exhibits have been made in the Courts of Canada, New Zealand, Australia, South Africa, Newfoundland, West Africa, the West Indies, Uganda, Fiji, Sudan, North Borneo (where an entirely new collection has been installed), Malaya and Ceylon and others, apart from the routine renewals involved in the maintenance of all the collections.

In recent years the total attendance annually has been in the neighbourhood of 100,000. Last year the total was 153,000, which includes 5,000 pupils from 180 different schools and institutions, who came in parties accompanied by their teachers, and who either visited in turn the collections of the principal countries of the Empire, the present position and resources of which were explained by the Guide Lecturer or other officer of the Institute, or attended separately with or without their teachers.

More than twice as many schools applied last year for conducted visits as could be dealt with by the present staff, and the same has occurred this year, when additional arrangements have been made to deal with a larger number. It is therefore clear that the Galleries of the Imperial

Institute are fulfilling an important public purpose in connection with the teaching of the commercial geography of the Empire. There is no other place in London where the nature and resources of all the British countries overseas, systematically arranged on a geographical basis, can be seen and studied side by side in one and the same building, with the assistance of maps, pictures, photographs, explanatory diagrams and models.

The following is a list of the principal districts from which schools requested the services of the Guide Lecturer during 1922–23: Acton; Balham; Battersea; Bedford Park; Bethnal Green; Blackheath; Brixton; Camberwell; Camden Town; Charing Cross; Chelsea; Chiswick; Clapham; Clapton; Crouch End; Deptford; Enfield; Finsbury; Fulham; Greenwich; Hackney; Hammersmith; Hampstead; Hanwell; Hendon; Holloway; Isleworth; Islington; Kennington; Kensal Rise; Kensington; Lewisham; Maida Vale; Marylebone; Paddington; Peckham; Plaistow; Purley; Putney; St. Georges, East; South Hampstead; Southwark; Stamford Hill; Stepney; Stoke Newington; Stroud Green; Tollington Park; Tottenham; Tower Hill; Walworth; Westminster; Whitechapel; Windsor; Wood Green.

Extracts from some recent letters received from schools which have attended are given in the Appendix (p. 267).

Last year over 8,000 descriptive pamphlets about the Dominions and Colonies, etc., were applied for by visitors, and issued from the Central Stand for Publications and General Enquiries in the Galleries, and many of these visitors camè with a definite enquiry in view.

In addition to the general public and schools, the Galleries are also visited by members of various institutes, societies and clubs who request special guidance for their members, such as the Geographical Association, the various polytechnics, the Union of Scientific Societies, and various field clubs.

Yet this work is only in its infancy. The total expenditure from the funds of the Institute on the Galleries has been very small. With a larger staff and further publicity far more could be accomplished. During the war the Galleries were taken by the Government for use as

offices and the contents removed, and it is only since 1920 that they have been restored and re-established with the exhibits after repair and re-decoration. Although numerous additions and improvements have been made throughout the collections, their further development and popularisation for the benefit of the general public and schools requires to be undertaken.

It is obvious that the collections at the Imperial Institute possess important advantages which are not secured elsewhere.

(1) All the countries of the Empire are represented in one building, which, from the educational as well as from other standpoints, is a most important advantage. Moreover, the large majority of these countries have no other permanent representation of any kind in this country.

(2) The Collections include not only products with descriptive labels stating their nature and uses prepared by an expert staff, but also maps, models, diagrams of trade and commerce, pictures, photographs of towns and industries, examples of native handicraft, and other illustrations which help to give a comprehensive idea of the present position of each country.

(3) In addition to the staff concerned with their care and maintenance, these collections are associated with the special departments of the Institute for intelligence, investigation and research, including an expert staff with scientific and technical knowledge of the occurrence, production and usage of the materials exhibited.

Besides being visited by schools and the general public, these collections are the starting-point for many of the enquiries and researches conducted by the Imperial Institute for the benefit of the countries concerned. Recently samples drawn from these collections were utilised for over fifty investigations conducted by the Scientific and Technical Department of the Imperial Institute. The collections are also used for the purpose of dealing with enquiries about the occurrence, value and supply of products, whilst the materials exhibited are in requisition for the purpose of supplying samples to manufacturers, merchants and other enquirers who are in communication with the Imperial Institute respecting their qualities, usage and

sources of supply. Last year samples of various products from the Exhibition Galleries were requested in connection with over seventy different enquiries.

Samples have also been supplied to museums, schools and other educational institutions and to various temporary exhibitions; and for the purposes of public lectures including those arranged by the branches of the Victoria League.

The collections are also continually utilised by the several technical committees of the Institute, composed of representatives of industries and trade, such as the general Committee on Raw Materials, associated with the Chambers of Commerce, and those on timbers, silk, etc., which are engaged in promoting the development of the production and the extension of the use of these materials within the Empire.

Recent controversy concerning the attempt to secure the greater part of these Galleries for the purposes of the War Museum, to which they were to be permanently transferred, has again drawn public attention to their value, and numerous testimonies to their importance have appeared in the press. *The Times* appointed a member of its staff to visit the Galleries with a view to the publication of information respecting them. His article on the subject, entitled, "Empire Trade Teaching," is reprinted in the Appendix (p. 269). Similarly *The Daily Telegraph* commissioned Sir William Schooling to conduct an enquiry, and his article, entitled "Courts of Empire," is also appended (p. 273).

It will be seen that each of these independent writers, who previously had no special knowledge of the Imperial Institute and its work, agrees in attaching high importance to the value of the Galleries and the need for the development and extension of their operations.

There is also appended (p. 277) an editorial notice which recently appeared in the principal scientific journal, *Nature*.

In connection with the proposals referred to, to use a large part of the Imperial Institute for the War Museum, it has been argued that the purposes of the Galleries are already better served by the show-rooms established by certain Dominions, etc., elsewhere in London. This

argument ignores the important value of the collections of the Imperial Institute as representing in one building the whole of the Empire, and also the fact that there is ample justification for the great Dominions having in this country more than one exhibition differing in scope and character, but co-ordinated so as to work together in the interests of the countries concerned.

It has also been alleged that the collections of the Imperial Institute have failed to attract the large numbers which are expected to visit the War Museum in the future, and that there are often few visitors to be seen in the Galleries of the Institute. There will be no difficulty in very largely increasing the number of visitors to the Galleries if greater publicity is given to them, and attention drawn to the interest they possess for every citizen of the Empire. No one, however, would expect these collections to have the same attraction for certain classes of the community as spectacular shows and entertainments.

In no museums of this special character is it to be expected that crowds of visitors will be present continuously, and there must always be occasions when there are few. Similar observations indicate that the same is true of the Dominions' Show-rooms in the City and elsewhere, though passers-by may be attracted to look at a window in which there is a striking display.

The attendance in the Galleries of the Imperial Institute compares very favourably with those in the Museums adjoining the Institute, having regard to the fact that the Galleries of the Institute are not open in the evenings or on Sundays when there is a large attendance at similar institutions.

In this connection mention may be made of some of the more important matters which it is intended to advance, now that the Galleries are again in order and funds are available for the purpose.

The public entrances are too inconspicuous from the road, and require substantial improvement.

Only one member of the staff has hitherto been available to act as a Guide Lecturer and explain the exhibits to visitors, and it has been necessary to refuse many applications for his services. Additional officers require to be

appointed for this purpose, especially having regard to the increasing requests from schools.

A small descriptive book on the countries of the Empire and their resources is needed. This would serve as a text-book for schools, and as a general guide to the collections of the Imperial Institute.

Special lectures by external lecturers on countries, their resources and industries need to be arranged, illustrated by the exhibits in the Galleries. This has been provisionally done this year, and has proved a success.

Temporary exhibitions illustrating the development of Empire products, supplementary to the permanent collections, should be held periodically, such for example as of timbers, silk, tobacco and others, on which the expert staff and committees of the Institute are at work. The few which have been held so far have been very successful and well attended, and serve in addition to a general educational purpose that of illustrating the Empire's part in furnishing these important commodities.

Want of funds and shortage of staff have prevented the holding in recent years of temporary exhibitions, but arrangements have now been made for an exhibition in conjunction with the Silk Association illustrating the progress of the cultivation of silk within the Empire, and of an exhibition of the commercial timbers of the Empire in conjunction with the Empire Forestry Association.

During the last two years exhibitions of the Presents and Addresses received by H.R.H. the Prince of Wales, in Canada, and of those received in Australia, New Zealand, and Fiji have been held in the Upper West Gallery, and in the same gallery the City and Guilds of London Institute have held an exhibition of technological work in connection with their examinations which are held in various parts of the Empire.

So far, again from want of funds, little or no publicity in the press has been given to the operations of the Imperial Institute. A Publicity Officer is required to give information, not only respecting the Galleries and their contents, but also about the important intelligence, investigation and research work which is being continuously conducted at the Imperial Institute on behalf of the Empire as a whole.

LIBRARY AND MAP-ROOM

The Library of the Imperial Institute contains a large collection of works of reference, and is regularly supplied with the more important official publications, and with many of the principal newspapers and periodicals of the United Kingdom, the Dominions, the Colonies and India. Special attention is given to publications relating to tropical agriculture and forestry, mineral resources, and the production and utilisation of raw materials.

The Library is in constant use in connection with the work of the Institute and is also used by enquirers and other visitors to the Institute.

The Library includes about 35,000 publications, and in addition over 500 serial journals, etc., are regularly received.

The Map-room is provided with a large collection of recent maps of the Dominions, the Colonies and India.

PUBLICATIONS

Bulletin of the Imperial Institute

The Bulletin of the Imperial Institute has been issued as a quarterly publication since 1903, and from 1912 onwards it has been published in a greatly improved and enlarged form by the firm of Mr. John Murray.

The Bulletin furnishes a quarterly record of progress in tropical agriculture and the commercial utilisation of the natural resources of the Dominions, Colonies and India. It serves also as a means of publishing the results of the principal investigations of the Institute throughout the Empire, and of disseminating information by special articles relating to the cultivation, preparation and economic possibilities of raw materials of all kinds.

Each number of the Bulletin includes:

(1) Reports of the more important investigations carried out by the Scientific and Technical Department of the Institute.

(2) Articles on the production, uses and marketing of raw materials of all kinds, vegetable, mineral and animal. These articles are illustrated as occasion requires by photographs, maps, etc. A prominent feature is made of the cultivation and preparation of tropical products, particularly those which are suitable for introduction into new countries.

(3) A special section is devoted to recent progress in agricultural and mineral developments in different parts of the world. This contains a summary of information published in Government and other publications, both British and foreign.

(4) Notices of new books relating especially to raw materials and their utilisation, and to the development of the countries of the Empire.

At present about 3,000 copies of each number are printed, and either sold to subscribers or issued in exchange for the publications of other organisations. The subscribers include Government departments, public institutions, business firms and private individuals in this country and in other parts of the Empire, and also in many foreign countries, including France, Belgium, Holland, Denmark, Finland, Italy, Switzerland, Spain, Morocco, French West Africa, Belgian Congo, Angola, Portuguese East Africa, Dutch East Indies, China, Japan, Siam, United States, Brazil, Ecuador and Argentina.

Copies are presented to those Governments which subscribe to the funds of the Institute and to a large number of Government Departments, Chambers of Commerce, Societies, etc., throughout the Empire, from which, in many cases, the Institute receives publications in exchange.

The Bulletin is edited by the Director and is chiefly prepared by the staff of the Institute, whilst special articles are contributed by other writers with expert knowledge of certain subjects, including agricultural and other officers in the Dominions and Colonies.

The reports and articles published in the Bulletin are regularly abstracted in the chief agricultural and technical journals throughout the Empire and many are reprinted either in whole or in part. Among the journals

which regularly publish either abstracts or reprints of articles from the Bulletin are :

England.—Tropical Life ; Nature ; Journal of the Royal Society of Arts ; Geographical Journal ; Bulletin of the Federation of British Industries ; Kew Bulletin ; Review of Applied Entomology ; Review of Applied Mycology ; Analyst ; Journal of the Chemical Society ; Journal of the Society of Chemical Industry ; Chemical Trade Journal ; India Rubber Journal ; Rubber Age ; Oil and Colour Trades Journal ; Perfumery and Essential Oil Record ; Paper Maker ; Paper Makers' Monthly Journal ; World's Paper Trade Review ; Journal of the Textile Institute ; Textile Manufacturer ; International Sugar Journal ; Journal of the Institute of Brewing ; Chemist and Druggist ; Pharmaceutical Journal ; Year-book of Pharmacy ; Journal of the Society of Dyers and Colourists ; Journal of the Society of Leather Trades' Chemists ; Leather Trades Review ; Leather World ; Timber ; Timber Trades Journal ; Mining Magazine ; Metal Industry ; Transactions of the Ceramic Society ; British Clayworker ; Raw Materials Review ; Waste Trade World.

India.—Agricultural Journal of India ; Indian Planters' Gazette ; Planters' Chronicle ; Indian Trade Journal ; Indian Industries and Power ; Indian Engineering ; Mysore Economic Journal ; Indian Textile Journal ; Quarterly Journal, Scientific Department, Indian Tea Association ; Indian Forester.

Dominions.—Canadian Chemical Journal ; Canadian Mining Magazine ; Queensland Agricultural Journal ; Agricultural Gazette, New South Wales ; Australian Forestry Journal ; South African Journal of Agriculture ; South African Journal of Industries.

Colonies.—Cyprus Agricultural Journal ; Tropical Agriculturist (Ceylon) ; Agricultural Bulletin, Federated Malay States ; The Planter (Malaya). ; Rhodesia Agricultural Journal ; Farmers' Journal (East Africa) ; Journal of the Gold Coast Agricultural and Commercial Society ; Journal of the Board of Agriculture, British Guiana.

United States.—Experiment Station Record ; Commerce Reports ; Chemical Abstracts ; Industrial and Engineering Chemistry ; India Rubber World ; Cotton

Oil Press ; Oil, Paint and Drug Reporter ; Spice Mill ; American Fertiliser.

Other Countries.—L'Agronomie Coloniale ; Revue de Botanique Appliquée et d'Agriculture Coloniale ; Bulletin de la Société d'Encouragement pour l'Industrie Nationale ; Chimie et Industrie ; Le Caoutchouc et la Guttapercha ; Bulletin des Caoutchoucs de l'Institut Colonial, Marseille ; Les Matières Grasses ; Bulletin des Matières Grasses de l'Institut Colonial, Marseille ; La Parfumerie Moderne ; Bulletin, Roure Bertrand Fils ; Travaux du Laboratoire de Materia Medica ; Bulletin Économique de l'Indo-Chine ; Bulletin Économique de Madagascar ; Journal de la Station Agronomique, Guadeloupe ; Bulletin de l'Office du Gouvernement Général de l'Algérie.

International Review of the Science and Practice of Agriculture (Rome) ; L'Agricoltura Coloniale, Rivista Coloniale ; Bulletin Agricole du Congo Belge ; Teysmannia ; Dutch East Indies Archipelago ; Colombian Trade Review ; Tropenpflanzer ; Chemisches Zentralblatt ; Gummi Zeitung ; Chemische Umschau ; Schimmel and Co.'s Reports on Essential Oils ; Collegium ; Der Gerber.

Handbooks to the Commercial Resources of the Tropics

In order to provide information respecting the more important vegetable products of the tropics, their cultivation and preparation, with special reference to the needs of West Africa, a series of handbooks on these subjects has been prepared at the Imperial Institute under the editorship of the Director and published by Mr. John Murray. The volumes already issued, some of which are now in their second edition, are :

The Agricultural and Forest Products of British West Africa, by Gerald C. Dudgeon, C.B.E., lately Consulting Agriculturist and Director-General of Agriculture in Egypt, and previously Inspector of Agriculture for British West Africa.

Cocoa : Its Cultivation and Preparation, by W. H. Johnson, F.L.S., formerly Director of Agriculture in Southern Nigeria.

Rubber: Its Sources, Cultivation and Preparation, by Harold Brown, Superintendent, Scientific and Technical Department, Imperial Institute.

Cotton and Other Vegetable Fibres; their Production and Utilisation, by Ernest Goulding, D.Sc., F.I.C., Scientific and Technical Department, Imperial Institute.

These Handbooks have had a large sale and are recognised as meeting an important need on the part of those engaged in the production of the commodities to which they relate.

Publications on Minerals

The series of monographs on mineral resources draw attention to the sources of supply of important minerals within the Empire as compared with those which occur in foreign countries, and give information respecting the commercial uses and value of these minerals. The following monographs have been published, and some are in a second edition:

Zinc Ores; Manganese Ores; Tin Ores; Tungsten Ores; Molybdenum Ores; Chromium Ore; Platinum Metals; Copper Ores; Lead Ores; Silver Ore; Mercury; Coal; Petroleum; Oil Shales; Potash. The publication of these monographs has been undertaken by the firm of Mr. John Murray.

A new and enlarged edition of the Map and Diagrams of the Chief Metal Resources of the Empire, prepared at the Imperial Institute with the advice of the Imperial Institute Committee on Mineral Resources, has been published by Messrs. George Philip and Son. The localities of the chief British countries in which the principal minerals are produced, or in which undeveloped deposits occur, are shown on the map. The diagrams give the outputs of these countries in relation to the production of other countries of the world. The metals dealt with are: gold, silver, platinum, copper, tin, lead, zinc, antimony, aluminium, bismuth, iron, manganese, chromium, nickel, tungsten, molybdenum, vanadium and mercury. The map and diagrams can be obtained unmounted or mounted on rollers as a wall map.

Mineral Survey Reports.—The following reports on the results of mineral surveys conducted in connection with the Imperial Institute have been published in the Miscellaneous Series of Colonial Reports :

Ceylon (five reports), 1903–4, 1904–5, 1905–6, 1906–8, 1909–10.

Northern Nigeria (five reports), 1904–5 (two), 1905–6, 1906–7, 1907–9.

Southern Nigeria (nine reports), 1903–4 and 1904–5, 1905–6, 1906–7, 1907–8, 1908–9, 1910, 1911, 1912, 1913.

Nyasaland Protectorate (three reports), 1906–7, 1907–8, 1908–9.

Reports of the Indian Trade Enquiry

The following reports of the Special Committees of the Imperial Institute, appointed in connection with the Indian Trade Enquiry to examine and report on the present position and prospects of trade in the more important raw materials of India (see p. 141), have been published by Mr. John Murray : Hides and Skins ; Oil Seeds ; Rice ; Timbers and Paper Materials ; Jute and Silk ; Lac, Turpentine and Rosin ; Cinchona Bark and Myrobalans.

Selected Reports from the Scientific and Technical Department

These reports, which were issued in the Miscellaneous Series of Colonial Reports, contain a summary of the results of technical and commercial investigation of certain raw materials conducted in the Scientific and Technical Department of the Imperial Institute between 1903 and 1914. Five of these Selected Reports have been published :

Part I. Fibres (1909).
Part II. Gums and Resins (1909).
Part III. Foodstuffs (1910).
Part IV. Rubber and Gutta Percha (1912).
Part V. Oil Seeds, Oils, Fats and Waxes (1914).

The issue of these reports was discontinued after the war. A collection of earlier reports was printed in a

volume of *Technical Reports and Scientific Papers* issued by the Imperial Institute in 1903.

Some reviews and notices of the Bulletin and other publications of the Imperial Institute are reprinted in the Appendix (p. 278).

SPECIAL REPORTS

SUMMARY OF INVESTIGATIONS CONDUCTED FOR THE DOMINIONS AND INDIA

The following is a brief account of some of the principal investigations and enquiries conducted by the Institute for the Dominions and India.

Canada

Minerals.—At the request of the High Commissioner in London the Imperial Institute made enquiries as to the reason why British manufacturers have preferred European to Canadian magnesite. The question was considered by the Mineral Resources Committee of the Institute and the principal users of the material were communicated with. The chief objection to Canadian magnesite was stated to be that it contains a larger proportion of lime than the European material, which renders it less suitable for refractory purposes. The results of analyses of samples at the Imperial Institute confirmed the statement that the Canadian mineral contains much more lime than European magnesites, and manufacturers who had carried out technical trials with Canadian magnesite reported that its refractory properties are not so good as those of the latter kinds. In view of these facts and of the higher transport charges it is doubtful whether Canadian magnesite will be able to compete successfully in the United Kingdom with the magnesite obtained from Greece and other European sources.

The Imperial Institute also supplied information to the Trade Commissioner in London as to the possibility of finding a market in the United Kingdom for crude and

calcined magnesite prepared in British Columbia from a hydro-magnesite reported to be free from lime.

A radio-active mineral, discovered at Maberly, Ontario, and supposed to be samarskite, was forwarded by the Ontario Bureau of Mines to the Imperial Institute for investigation. A detailed examination of the specimen showed that it was not samarskite but euxenite, a rare mineral which would be of value as a source of uranium and radium if available in sufficient quantities. A sample of the crude mineral from the deposit was also examined, but was found to contain less than 10 per cent. of euxenite; it was therefore suggested that attempts should be made to concentrate the material, and a sample of better quality was subsequently forwarded. There is no doubt that the separated mineral in quantity would find a ready market, and the Imperial Institute obtained an offer from a British firm to purchase a consignment.

During the war the Ministry of Munitions applied to the Imperial Institute for information as to sources of supply of orthoclase felspar of good quality which was required for the manufacture of certain types of glass. Particulars were furnished of the felspar deposits in Ontario, including statements of the composition of the mineral and statistics of production, together with a list of the producing firms in Canada. Other enquiries from Canada as to marketing of felspar in the United Kingdom have since been received.

Applications were also received from firms in the United Kingdom as to supplies of high-grade manganese dioxide suitable for making dry electric batteries and for the production of paint driers, etc. Enquiries made by the Institute showed that manganese ore of the required quality was being produced at a mine in Canada, and samples and prices of the different grades of ore which could be supplied were obtained. As a result, offers to purchase consignments were obtained from British firms, who were placed in communication with the producers in Canada.

At the outbreak of war the Institute took active steps to increase the production in the Empire of molybdenum and other metals urgently required for the manufacture

of special steels for munition purposes. A memorandum was prepared stating the quality of the molybdenum ore required in this country, the possible sources of supply within the Empire, the value of the ore, and the chief uses to which it was applied. Copies of this memorandum were sent to the Mines Departments in those parts of the Empire where molybdenum ores were known to be obtainable. This action was specially effective in Canada, where a large increase took place in the production of molybdenum ore as a direct result of the action taken by the Canadian Department of Mines in response to the memorandum issued by the Institute. The total quantity of molybdenum ore mined in Canada rose from 148 long tons in 1914 to 30,384 long tons in 1918.

A specimen of celestite (strontium sulphate), received from Ontario for valuation, was proved to contain a considerable amount of barium sulphate. It would consequently not be suitable for the manufacture of strontium salts, but might be utilised for the production of a white pigment. There is little likelihood of finding a market for Canadian celestite in the United Kingdom, owing to the supplies already available here, but the producers were put into communication with the agents of a British firm in America who might be able to assist in the disposal of the material.

Other Canadian minerals which have been investigated at the Imperial Institute and reported on include zinc ores, iron ores, diatomites, and siliceous earths for polishing.

Timbers.—In view of the difficulty of obtaining adequate supplies of the softwoods required in this country for general constructional purposes, which were formerly derived from Russia and Scandinavia, there is now a favourable opportunity for further developing the timber trade between Canada and the United Kingdom, and action in several directions has accordingly been taken by the Timbers Committee of the Imperial Institute, with a view to extending the use of Canadian timbers in this country.

Reports have been furnished to the Canadian Government on British Columbian and Eastern Canadian timbers, and suggestions have been made with a view to facilitating the export of certain of these timbers to England in

increasing quantities. The principal constructional timbers of British Columbia, viz. Douglas fir, Sitka spruce and Western hemlock were considered by the Committee to be well adapted to the needs of consumers in the United Kingdom, and likely to obtain an established position in this market if brought prominently to the notice of architects, merchants and others. In the case of Eastern Canadian woods, the Committee, as a result of their enquiry, were able to recommend a number of valuable softwoods and hardwoods whose merits entitle them to wide utilisation in the United Kingdom.

The Imperial Institute has also dealt with the question of the inclusion of British Columbian timbers in the official Timber Specifications for Government buildings in the United Kingdom. In consultation with H.M. Office of Works it was arranged that mechanical tests and practical working trials, including extended joinery tests, should be carried out with Douglas fir, Western hemlock and Sitka spruce. The results of the mechanical tests showed that the British Columbian timbers are equal, if not superior, in strength to similar European timbers, whilst the practical joinery tests were entirely satisfactory. As a result of these tests the woods are now included in Government Building Specifications.

At the request of the Forest Products Laboratories in Canada, the Timbers Committee have advised as to the best means of bringing the results of mechanical and other tests of Canadian timbers to the notice of merchants, architects and others in the United Kingdom, and have offered to render any additional assistance which may be desired in this important matter.

Poisonous Plants.—A serious disease in cattle, known in Nova Scotia as "Pictou disease," in which the animal suffers from a kind of hepatic cirrhosis, was thought to be caused by the common ragwort, *Senecio Jacobæa.* The toxic properties of this plant have therefore been the subject of detailed investigations at the Imperial Institute. A poisonous alkaloid was isolated from the plant, and physiological trials proved that this alkaloid was the cause of "Pictou disease."

An enquiry regarding the alleged development of

poisonous properties in certain beans imported into Canada was received from the Laboratory of the Inland Revenue Department at Ottawa, in connection with the question of controlling the admission of such beans into the Dominion. Information was supplied as to the results of investigations carried out at the Imperial Institute on the development of prussic acid in beans grown in tropical countries, and attention was drawn to those classes of beans in which the amount of prussic acid is liable to be dangerous.

Hides.—The Hides and Tanning Materials Committee of the Imperial Institute considered the question of finding markets for the large quantities of the light Indian cow-hides (kips) which had been exported to Germany and Austria, and the Committee suggested that these hides might be of value to Canadian tanners. Preliminary enquiries on this point were made through the High Commissioner, with the result that a number of firms in the Dominion expressed considerable interest in the matter; several firms desired to purchase sample bales of the kips for trial, whilst others stated that they would like to inspect representative samples. With the co-operation of the Indian firms concerned, small trial consignments of the kips were accordingly forwarded to those tanners who had specially asked for them, and, in addition, the Committee arranged for the despatch of a representative collection of the kips for exhibition throughout Canada. The Department of Trade and Commerce took charge of this exhibit, which was shown at convenient centres throughout the Dominion, and was subsequently sold to a firm of tanners at Toronto.

Miscellaneous Products.—In connection with the work of the Imperial Institute on new materials for paper-making, an examination was made of "spent" hemlock bark from Canada in order to determine whether this waste material could be used like "spent" wattle bark for the manufacture of paper. The material proved to be unsuitable for this purpose if used alone, as the pulp was difficult to beat and also to bleach; but the results of the investigation showed that it might possibly be utilised in admixture with material of a more fibrous character for the production of cheap brown paper or mill boards.

The assistance of the Imperial Institute was requested by the Trade Commissioner, on behalf of the Canadian Department of Trade and Commerce, in connection with the disposal of supplies of acetic acid, acetone, and related materials produced in Canada by a new manufacturing company. Particulars were supplied by the Institute as to the industrial uses of these materials and the extent of the demand for them in the United Kingdom, together with the available statistics as to existing supplies. Information was also furnished as to the prospects of finding a market in the United Kingdom for synthetic indigo if its production were undertaken in Canada.

Special statistical information regarding dairy produce in the United Kingdom was supplied by the Institute to the Dairy and Cold Storage Commissioner at Ottawa. An enquiry was also received from the Trade Commissioner in London for information regarding the utilisation of soy beans for the manufacture of artificial milk. Particulars respecting the processes used and the names of makers of machinery were supplied, together with general information as to the prospects of the industry.

Newfoundland

The work conducted for the Dominion of Newfoundland has been concerned largely with the development of the mineral resources of the country. Included amongst minerals of economic importance examined and reported on as to their commercial value are chrome ore, iron ores, copper ores, lead-zinc ore, bismuth ore, molybdenite, barytes, cement materials and oil shale.

Much attention has also been devoted to the question of extending the market in this country for Newfoundland refined cod-liver oil for medicinal use. Trials of Newfoundland cod-liver oil conducted at a London hospital by arrangement with the Imperial Institute demonstrated that the Newfoundland oil was just as effective as the Norwegian medicinal oil previously given to the patients. The Institute drew the attention of users of refined cod-liver oil in this country to the qualities of the Newfoundland product, and supplied particulars to the producers in Newfoundland as to several points requiring special attention.

AUSTRALIA

Minerals.—A large number of minerals from Australia have been examined at the Imperial Institute, the most important of which are included in the following list: Pottery clays, kaolin, alunite, diatomite, mica, asbestos, graphite, talc, magnesite, barytes, arsenic, corundum, rutile, sapphires, emeralds, platinum, osmiridium, tantalite, yttro-tantalite, monazite sand, glass sands, carnotite, chromite, copper-mercury ore, manganese ore, oil shale and petroleum.

An examination of a radio-active ore from Radium Hill, South Australia, showed that it consisted chiefly of ilmenite, but contained small quantities of the mineral carnotite, to which the radio-activity is due. The carnotite was not sufficiently abundant to make the ore of commercial value, but the results of the investigation were of considerable scientific interest, and a paper on the subject was communicated to the Mineralogical Society.

In 1911 petroleum was discovered in Papua, and a sample of the crude oil, examined at the Imperial Institute, was found to contain a high proportion of petrol and kerosene. The Commonwealth Government decided that a careful survey of the area should be made, and in 1913 a competent economic geologist and an assistant, selected by the Imperial Institute, commenced a systematic investigation of the oil-fields, in co-operation with the Government Geologist of the Territory of Papua. These preliminary investigations yielded promising results. The work of exploration is being continued by the Australian Government.

At the outbreak of war there was a considerable shortage in the United Kingdom of diatomite required for certain technical purposes, owing to the cessation of supplies from Germany. The Imperial Institute drew the attention of users to the possibility of obtaining supplies from Australia, and procured for examination representative samples of diatomite from several localities. The materials were found to be suitable for use by manufacturers in this country, and a considerable number of firms were placed in communication with the producers in Australia with a

view to obtaining supplies. Australian diatomite was subsequently shipped in quantity to this country.

During the war the Imperial Institute carried out for the Ministry of Munitions a series of investigations on possible sources of potash, of which supplies were then urgently required for the manufacture of optical glass. One of the materials suggested for the purpose by the Institute was Australian alunite, and a complete process for the preparation of potash, alumina and sulphuric acid from this material was devised.

Practical trials with a pottery clay from Victoria showed that the material, after suitable preparation, could be utilised for the manufacture of white permeable pottery and fine white earthenware and in conjunction with felspathic material for "semi-porcelain." In accordance with the suggestion that further trials should be carried out at the Institute from this point of view with felspathic or siliceous materials of local origin, such materials were subsequently forwarded and the work was continued. The results confirmed those obtained previously, and it was suggested that large-scale trials should be carried out in order to determine the working properties of the clay under industrial conditions. Specimen vessels made at the Institute with the clay alone and with mixtures of the clay with quartz and felspar were forwarded with the report.

Paper-making Materials.—The shortage of wood pulp during the war led to proposals being made in Australia for utilising materials available in the Commonwealth for the manufacture of paper, and a number of products were forwarded to the Imperial Institute for examination in order that their value for this purpose might be determined. Samples of bamboo grass from the Northern Territory and of lalang grass from Papua were found to be of promising character as paper-making materials, as they furnish satisfactory yields of pulp from which paper of good quality can be made.

Another promising material was a rush-like plant from Western Australia. It would not be remunerative to export these materials from Australia owing to their bulky nature, but it may be possible to utilise them for the manufacture of paper or pulp in the Commonwealth if

they can be collected and delivered to a mill at a suitable price.

In connection with this subject, researches carried out for South Africa at the Imperial Institute proved that "spent" wattle bark after use by the tanner can be utilised for the preparation of strong wrapping paper, or, after suitable treatment, for making the cheaper grades of cream or white paper. As large quantities of wattle bark are used by Australian tanners, these results were communicated to the Commonwealth Government in order that the possibilities in Australia might be considered.

An examination of Australian mallet bark showed that this bark was not likely to be of value for paper-making owing to its non-fibrous character.

At the request of the Government of South Australia the Imperial Institute furnished comments on a proposal to install a mill in South Australia for the manufacture of paper and mill-board from cereal straw, and obtained estimates of the cost of the necessary plant. In addition, information was supplied as to a new process for the manufacture of paper from straw, together with samples of the manufactured paper. The Institute also furnished a memorandum on esparto grass and the possibility of its cultivation in Australia.

Investigations have also been conducted by the Institute to ascertain the value of the prickly pear as a paper-making material.

Fibres.—Considerable attention has been devoted to the possibilities of establishing a cotton-growing industry in Australia, and a number of samples grown in Queensland, Western Australia and Papua have been reported on by the Imperial Institute. Information has been supplied to enquirers as to the suitability of certain localities for the cultivation of cotton.

Other fibres examined include flax, silk, Mauritius hemp, bowstring hemp, Kingia fibre, Xanthorrhœa fibre, the fibre of *Posidonia australis*, and Sisal hemp grown in Papua.

Oilseeds, Oils and Fats.—A series of oils, prepared during the Australasian Antarctic Expedition, 1911–14,

were forwarded for examination to the Imperial Institute by Sir Douglas Mawson in order to ascertain their commercial value in the United Kingdom. The specimens included sea-leopard oils, Weddell seal oils and penguin oil. The characters of the oils were determined in comparison with oils of a similar kind, and samples were submitted to buyers of such oils. The oils were of good quality and could be utilised for the purposes to which commercial seal and whale oils are applied, viz. for soap-making, leather-dressing, etc., and also after certain treatment for edible purposes. There would be a ready sale for consignments of any of these oils.

At the request of the High Commissioner in London the Imperial Institute reported on a new mechanical process for the extraction of fat from waste wool-washing liquors, particulars of which were desired by the Commonwealth Advisory Council of Science and Industry in connection with an enquiry as to the practicability of manufacturing lanolin in Australia. The process was inspected in operation and a detailed report was furnished giving particulars of the plant, the method of working, and the yield of lanolin obtained, together with an opinion as to the probable value of the process. A separate memorandum was also supplied describing other processes in use for the preparation of wool fat.

The character and market value of copra produced in Queensland has also been reported on.

Essential Oils.—The composition of the oil of Western Australian sandalwood has been determined at the Imperial Institute in comparison with that of the oil of Indian sandalwood, and the possibilities of its utilisation in medicine and perfumery have been investigated.

A specimen of the volatile oil of the wild shrub known as *Stirlingia latifolia*, which is abundant in Western Australia, proved to be of considerable interest as it was found to consist almost entirely of acetophenone, a substance which appears to have been previously recorded as occurring in only one other volatile oil. Artificially prepared acetophenone is used in medicine, and has also been employed in soap perfumery, and it is possible that the Stirlingia oil would find a market for the latter

purpose if it could be produced on a commercial scale at a suitable price.

The results of the examination of Huon pine oil from Tasmania showed that its characters and composition would probably render it saleable in the United Kingdom. Essential oil distillers who were consulted expressed favourable opinions on the oil and a consignment was requested in order to test the market, together with information as to the quantity likely to become available and the price at which it could be offered.

Resins.—The Imperial Institute has carried out an extended examination of Xanthorrhœa resin (grass-tree or black boy gum) with a view to discovering satisfactory commercial uses for this material. The investigation included the possibility of utilising the resin for the manufacture of picric acid; for making lacquers and varnishes, sealing wax and signal flares; and also its value as a dye. The most promising outlet for the resin appears to be for the production of lacquers and varnishes, either alone or in admixture with shellac or other substances. Assistance has recently been rendered by the Imperial Institute to the representative of an Australian company who are placing specially prepared Xanthorrhœa resin on the market as a varnish material. A preliminary examination of the chemical reactions and decomposition products of the resin has also been made at the Imperial Institute with a view to determining its constitution and the possibility of obtaining from it substances of industrial value. The outlook for utilising the chemical disintegration products of the resin is however not very hopeful. The results of the preliminary investigation were communicated to the Advisory Council of Science and Industry, who, it was understood, intended to carry on further chemical investigations in Australia.

A sample of so-called "Nauli gum," an oleo-resin from the Solomon Islands, has been examined for the Commonwealth Institute of Science and Industry. It was found that the volatile oil was suitable for use as a substitute for aniseed oil, whilst the resin could be used for varnish making and would be equal in value to ordinary rosin of the same colour.

Miscellaneous Products.—The cause of damage to a consignment of tins of pineapple was investigated, and suggestions were made for the prevention of such damage. Other materials examined and reported on include Hevea, Ceara, Ficus and vine rubbers; tobacco from Papua; various drugs and tanning materials; sponges; ambergris; and pearls and pearl-shell.

It will be observed that several of the investigations referred to were conducted at the suggestion of the Institute of Science and Industry in Australia. In 1920 that Institute passed the following resolution with regard to co-operation with the Imperial Institute:

"The Executive Committee welcomes the proposal made to it on behalf of the Imperial Institute by Sir Muirhead Collins that the Commonwealth Institute should maintain touch with the Imperial Institute by exchange of information and other forms of co-operation."

New Zealand

Fibres.—A number of questions connected with the production of New Zealand hemp have been investigated at the Imperial Institute. Samples of the fibre submitted by inventors of special processes were examined at the request of the High Commissioner and reports furnished as to their quality in comparison with commercial grades of the fibre and as to the probable value of the processes of preparation. Samples of the by-products of the industry, *e.g.* tow, waste and "gum," were also examined. It was found that the waste, of which large quantities are stated to be obtained in preparing the fibre, would be of value as a manure, for which purpose either the original material or the ash obtained on burning it could be employed. The ash might also be utilised as a source of potash salts.

Kapok produced in Samoa was found to be rather softer and less resilient than ordinary Java kapok, and would therefore be less valuable in this country than the latter product.

Timbers.—Large quantities of waste wood are produced annually in New Zealand as a by-product of the timber

industry, but only a small portion is utilised as fuel. In view of this position the Imperial Institute drew up a Memorandum on the Utilisation of Waste Wood in New Zealand, in which attention was drawn to the various purposes for which this wood might be used. This Memorandum was forwarded to New Zealand with the suggestion that samples of waste wood and sawdust from each species of timber worked in New Zealand should be sent to the Imperial Institute for investigation. In response to this suggestion the Forestry Department forwarded specimens of eight timbers in order that their suitability for the production of wood pulp might be determined. Some of them furnished satisfactory yields of pulp of good quality which bleached readily and would be suitable for the manufacture of paper in New Zealand. The commercial possibilities of utilising the woods for this purpose are now being investigated by the Forest Department.

The Timbers Committee of the Imperial Institute has considered, at the request of the Committee for New Zealand, the questions of the possible increased utilisation in the United Kingdom of Kauri pine and New Zealand beech timbers. The Committee furnished a detailed report on Kauri pine and its various uses and expressed the opinion that the excellent qualities of this timber and the large sizes in which it is available render it most valuable for a great variety of purposes. There is no doubt that its use in the United Kingdom can be largely extended if it can be supplied at a price to compete with other cheap hardwoods. The Committee also drew attention to the importance of safeguarding future supplies of this timber, and urged that the questions of afforestation and the conservation of existing supplies should receive the attention of the Dominion Government. A copy of this report was forwarded to New Zealand and, in reply, it was stated that the increasing scarcity of Kauri pine and the high price which it realises locally will much curtail, if not altogether stop, its export to Europe. The planting of Kauri is, however, to be tried and the remaining forests are to be worked so as to furnish a sustained supply of the timber.

With reference to the New Zealand beeches (*Fagus* spp.)

which have not apparently been introduced into the English market, the Timbers Committee of the Institute examined samples of red beech from the New Zealand Collections at the Imperial Institute. This species furnishes a compact timber, of good appearance and strength, which could probably be utilised for a variety of purposes in the United Kingdom, *e.g.* in the furniture trade, for cabinet-making, bobbins, spools, tool-handles and turnery, and possibly for wagon-building. Subsequently a specimen of Southland beech was received from New Zealand and was found to be suitable for the same purposes as the red beech. There is no doubt that these beech timbers could be utilised in the United Kingdom, but the controlling factor will be the price at which they can be offered in competition with other similar woods.

Trials were also made to determine the suitability of Southland beech for making boot-lasts in place of American rock maple, of which supplies were then scarce. The timber proved to be suitable for the purpose, although not so good as rock maple. It might, however, be utilised for boot-lasts in New Zealand, and suggestions on this point, together with sample lasts made from the wood, were forwarded to the Dominion.

At the request of the New Zealand Committee of the Institute, the Timbers Committee also prepared, for transmission to New Zealand, a full report on methods for the preservation of structural timber from attacks by boring insects. In acknowledging its receipt the Prime Minister stated that this very able and exhaustive report will be invaluable to the newly-created Forest Department in dealing with enquiries on this subject.

Oils and Oilseeds.—The assistance of the Imperial Institute was requested in connection with the possible utilisation of candle nuts, a consignment of which was forwarded from the Cook Islands. The nuts furnished the average quantity of oil, which possessed the usual characters of candle-nut oil from other sources. This oil is suitable for the manufacture of paints and soft soap, but cannot be used for edible purposes owing to its purgative properties. The kernels of the nuts or the oil would be readily saleable in the United Kingdom if available in

large and regular quantities, and information was therefore supplied by the Imperial Institute as to methods of preparing the kernels for export.

Suggestions were made regarding the preparation of the copra of Samoa in order to obtain material of better colour and appearance.

A memorandum was furnished at the request of the High Commissioner regarding the prospects of cultivating the African oil palm in Samoa. Information was supplied regarding the soil, elevation, climatic and other conditions required for the successful growth of the palm, and a supply of seed of West African varieties of the oil palm was obtained for trial cultivation.

Minerals.—A number of clays from the neighbourhood of Auckland were examined in order to determine their suitability for the manufacture of aluminium. The composition of the clays was found to be unsatisfactory for this purpose, but technical trials made at the Imperial Institute indicated that they could be utilised for the manufacture of porcelain, pottery or tiles, or for cement-making if used in conjunction with a good limestone.

Other matters relating to minerals which have been dealt with include the utilisation of titaniferous iron sands and iron ores of Parapara and Onekaka; petroleum from Kotuku; and the production of platinum and mercury in New Zealand.

Miscellaneous Products.—The quality of the cocoa produced in Samoa has received attention. Fifteen samples prepared by different methods were examined, but they proved to be inferior in quality to the best Samoan cocoa which comes on the market, and it was recommended that an endeavour should be made to produce only high-grade beans of pure Criollo type, known commercially as "Finest Samoa." Sixteen samples received subsequently were somewhat better, but they were still too mixed to be regarded as a good quality of Samoa cocoa, and they had moreover been imperfectly prepared.

Information was furnished regarding the production of potash and lanolin from wool-washing liquors. A sample of lanolin received for examination was found to comply with the British Pharmacopœia standard.

South Africa

Paper-making Materials.—A large number of paper-making materials from South Africa have been examined at the Imperial Institute, including numerous grasses, papyrus, baobab wood and bark, eucalyptus wood and other fibrous products. The reports furnished have indicated which of these materials are the most promising for practical use in South Africa for the manufacture of pulp or paper. The Institute has also shown that "spent" wattle bark, which has hitherto been a waste product after use by the tanner or the manufacturer of wattle extract, forms a useful paper-making material, and that waste wattle wood can also be utilised for the same purpose. The results of these investigations were brought to the notice of the paper trade in this country with the object of creating interest in the subject of paper manufacture in South Africa. The utilisation of papyrus for the production of paper pulp has since been undertaken in Zululand, and proposals have been made to start the manufacture of paper pulp from "spent" wattle bark and other materials in Natal.

Fibres.—The expanding cotton-growing industry of South Africa has also received much attention. A large number of samples of cotton grown in Natal, Cape Province, Zululand, Swaziland, and other parts of the Union have been examined and their quality and suitability for the English market reported on.

Other South African fibres examined at the Institute as to their possibilities and commercial value have included Sisal hemp, Mauritius hemp, bowstring hemp, jute, Hibiscus and Triumfetta fibres, silk, wool and various flosses.

Drugs and Poisonous Plants.—A large number of poisonous plants which cause serious mortality amongst live-stock in South Africa have been submitted to detailed chemical examination at the Imperial Institute, with the objects of ascertaining the nature of their poisonous constituents and of enabling effective action to be taken to prevent loss of animals. Species of Senecio, allied to the groundsel and ragwort of Great Britain, were suspected as

the cause of "Molteno disease," which affects cattle and horses and induces hepatic cirrhosis. Examination of *S. latifolius* at the Institute resulted in the isolation of two alkaloids, and pharmacological trials carried out by Prof. A. R. Cushny, F.R.S., of University College, London, with pure alkaloids supplied by the Institute, demonstrated clearly that the Molteno disease is due to these alkaloids. Other poisonous plants investigated at the Institute include *Acokanthera venenata*, to the use of which several cases of both criminal and accidental poisoning have been traced in South Africa, Cape slangkop, Transvaal tulp, gift-blaar, *Chailletia cymosa* and *Crotalaria Burkeana*, all of which are dangerous to stock in South Africa and cause many deaths annually.

Amongst drugs which have received attention are Stramonium roots and leaves, *Datura Metel* leaves, Digitalis leaves, Erythrophleum bark, buchu leaves and various adulterants of this drug, and the bark and fruits of the "hard pear" tree (a species of Strychnos).

Oils, Oilseeds; Fats and Waxes.—The oilseed crushing industry of South Africa is at present comparatively small, and much of the seed used is imported. Attempts are being made, however, to extend the cultivation of various oilseeds, and a number of locally grown products have been examined in order to determine their quality. Amongst the more important of these may be mentioned linseed, sesame, castor seed and ground nuts. Numerous lesser-known oilseeds have also been examined and the nature and uses of the oil investigated ; included in this category are the seeds or nuts of *Madia sativa, Ximenia americana, Heeria paniculosa, Pappea capensis, Jatropha Curcas, Argemone mexicana*, manketti nuts, maroola nuts and candle nuts.

At the request of the Department of Agriculture on behalf of the Cotton Growers' Association, Durban, assistance has been rendered by the Imperial Institute in connection with proposals for the grading and better utilisation of the cotton seed produced in the Union. Representative samples of South African cotton seed were examined in comparison with the commercial Bombay and Egyptian seed sold in the United Kingdom, and "fair

average" samples of the latter seeds were furnished, together with particulars of the terms on which cotton seed is bought by oilseed crushers in the United Kingdom.

The Imperial Institute has also supplied technical information to South Africa as to processes for the recovery of fat from waste wool-washing liquors and has reported on the quality and value of the product. A trial consignment of about two tons of crude wool fat sent to the Institute was disposed of to a firm of manufacturing chemists, who reported that it was equal to the crude wool fat produced in the United Kingdom and quite suitable for the preparation of lanolin for pharmaceutical purposes. The manufacturers were put into communication with the producers in South Africa with a view to obtaining further consignments.

The Imperial Institute carried out an investigation of the wax present in the refuse press cake obtained in the extraction of sugar from sugar cane. The yield and nature of the wax and also its possible industrial uses were determined and attention was drawn to the possibility of preparing it on a commercial scale. Experiments were subsequently made in Natal on the extraction of this wax and the Imperial Institute reported on a number of samples obtained there. The wax has now been produced commercially in Natal and shipped to this country. Reports have also been furnished on Cape berry wax, the production of which is an important minor industry in South Africa.

Essential Oils.—A detailed chemical examination of the oil of the leaves of *Barosma venusta* showed that it differs considerably from the oil of commercial buchu leaves. *B. venusta* leaves could therefore not be used in medicine as a substitute for ordinary buchu.

Other essential oils examined include that from Sherungulu tubers which could probably be used in perfumery, and the oil of *Mentha longifolia*, which proved to be similar in character to American spearmint oil.

Tanning Materials.—The Institute has devoted much attention to the subject of the South African wattle bark industry. A large number of samples of bark produced in Natal, Transvaal and the Cape Province were examined in order to determine the amount of tannin present, more

particularly in relation to the age of the tree from which the bark had been collected, and the attention of tanners in the United Kingdom was directed to the value of the bark by means of articles in the quarterly Bulletin. On the outbreak of war, when some of the usual sources of supply of tanning materials were cut off, the Institute again called the attention of British consumers to the South African bark, a special circular being prepared and circulated to tanners and firms engaged in the importation of tanning materials. As a result a number of firms began using the bark, and have continued to do so, with the result that far larger quantities of the bark have been used in this country than before the war. In addition, the Institute rendered assistance in starting the manufacture of wattle extract in South Africa, large quantities of which are now exported.

Other South African tanning materials examined and reported on by the Institute include Acacia pods, Transvaal sumach, the barks of various indigenous trees and a locally-used material known as "Eland's boontjes."

Hides.—Suggestions were made by the Hides and Tanning Materials Committee of the Imperial Institute that South Africa might be able to utilise with advantage some of the light Indian cowhides (kips) which were exported to Germany and Austria before the war. After preliminary enquiries had been made in South Africa the Imperial Institute arranged for a representative shipment of the hides to be forwarded from Calcutta. Although a much larger shipment was made than had been intended by the Committee, it was disposed of by the Department of Mines and Industries to tanners in the Union and very favourable opinions of the hides were expressed as the results of the practical trials. Steps have been taken by South African tanners to obtain regular consignments of the kips from India, as it was considered that the hides would be of the greatest value to manufacturers of light leather in the Union, and large quantities were subsequently imported.

Minerals.—At the request of the High Commissioner the Institute considered the question of the utilisation of "dump" coal, of which large quantities are wasted

annually in South Africa. It was suggested in the report that the material might be employed for the development of electrical power; for briquetting; or for carbonisation for the production of coke and by-products. These suggestions were subsequently considered by a Sub-committee of the Advisory Board of Industry and Science, who expressed the opinion that the most promising method of utilisation would be by carbonisation. If it is found possible to use the material for this purpose it will be a great advantage to South Africa, where not only the coke but also the by-products will be of value.

A large number of other minerals from South Africa have been examined and their composition and commercial value determined. These include asbestos, mica, talc, diatomite, graphite, china clay, glass-making materials, oil shale, soda, ochres and other pigments, monazite, columbite, osmiridium, platinum, radium-bearing ores, garnet, beryl, zircon, molybdenite, chromite, iron ore and tin ore.

Miscellaneous Products.—The Institute was instrumental in reintroducing South African boxwood to the home markets. For some years English manufacturers had used almost exclusively supplies of boxwood from Turkey and Persia, but during the war these boxwoods were unobtainable. Manufacturers were supplied by the Imperial Institute with samples of the South African wood and requested to make trials with it. This wood proved to be satisfactory for their purposes, and arrangements were made with buyers for shipments of boxwood from the Union. The export of the wood from South Africa has since continued.

Among the numerous foodstuffs examined and reported on, mention may be made of tea, chicory, oats, maize, barley, kaffir corn, teff seed, Sesbania seeds, velvet beans, arrowroot and ginger.

Other products examined include a number of tobaccos; various dyestuffs; several indigenous rubbers, including species of Landolphia, Ficus, Conopharyngia, and Raphionacme; the resinous latex of *Euphorbia Tirucalli*; seaweed as a source of potash; the roots of *Mesembryanthemum Mahoni* as a yeast substitute; the resin of the Oyster Bay

pine; vegetable ivory nuts; sponges; sheep skins; and locusts as poultry food.

INDIA

Foodstuffs.—An investigation of the poisonous nature of certain kinds of beans produced in Burma has been proceeding at the Imperial Institute. It has been shown that the red Rangoon beans exported from Burma yield a certain amount of prussic acid when ground into meal and mixed with water, and although the quantity is usually harmless, the fact that prussic acid may be formed has caused agriculturists to regard the beans with suspicion. The white Rangoon beans, on the other hand, yield little or no prussic acid. With a view to producing a more valuable kind of bean in Burma for export, the Institute suggested to the local Department of Agriculture that other varieties should be tried, and samples of white butter beans (Madagascar beans) were forwarded by the Institute for this purpose. The beans have now been grown for about ten years and specimens of each year's crop have been forwarded for examination. On the whole, little deterioration in quality has been observed, whilst the quantity of prussic acid yielded by the beans is negligible and quite harmless. Numerous other beans have been examined in connection with this investigation, including selected varieties of Rangoon beans and varieties of haricot beans. The composition and commercial value of a large number of indigenous beans have been also determined.

A considerable quantity of barley is exported from India to this country for malting purposes. In 1913 the Imperial Institute called attention to the fact that early shipments of Indian barley germinated well, while the later shipments were liable to contain a large percentage of grains that would not germinate. As this defect lowered the value of the barley for malting, the matter was referred to the Department of Agriculture, United Provinces, with the suggestion that the poor germination might be due to exposure of the barley to the humidity and warmth of the rainy season, followed by the drying of the grain before it reached England. The results of experiments conducted in India, and recently published by the Indian

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Department of Agriculture, confirmed the suggestions of the Institute, and recommendations have now been made that on account of the humidity of North-Eastern India during the monsoon barley should not be shipped from Calcutta after May but should be transported from the danger-zone towards Karachi or Bombay not later than the end of June.

Amongst other foodstuffs examined may be mentioned wheat, maize, rice, millet, tea, chillies and sweet potato starch.

Oils, Oilseeds and Waxes.—The characters, uses and commercial value of the oils from a large number of Indian oilseeds have been determined. These include ground nuts, linseed, safflower seed, soy beans, various kinds of rape seed, Indian kapok seed (*Bombax malabaricum*), perilla seed, tea seed, and the seeds of Calophyllum, *Amoora Rohituka*, *Vateria indica*, *Mesua ferrea*, Hydnocarpus, *Schleichera trijuga*, and species of Bassia. Series of fish oils and porpoise oils have also been examined. The work of the Indian Trade Enquiry on Indian oil seeds is referred to on p. 141, and the action taken by the Institute in finding a market in this country for Indian copra and ground nuts during the war is dealt with on pp. 230, 232.

In connection with statements made by importers in this country that Indian beeswax is extensively adulterated in India (mostly with paraffin wax), a comprehensive series of authentic waxes, from various districts and from the different species of bees common in India, was forwarded at the suggestion of the Imperial Institute with a view to establishing the constants of the genuine unadulterated material. The results of chemical and physical tests showed that Indian beeswax differs considerably in its constants from the wax from most other countries, and that the tests generally used for detecting the presence of paraffin wax in beeswax are of little value when applied to the Indian product.

Essential Oils and Resins.—Extensive areas of pine forests exist in the United Provinces and Punjab, and the question of working them to obtain turpentine oil and rosin has received much attention. The characters of the oil and rosin obtained by distilling the crude oleo-resins of the

different species of Indian pines have been determined at the Imperial Institute, and full enquiries have been made amongst users in this country with a view to ascertaining their exact industrial value. As regards the oil from the chief Indian pine (*Pinus longifolia*), which is the species now being exploited, it has been shown that it differs chemically from the best French and American turpentine oils, but that it can be used quite well for making certain kinds of varnish and is about equal in value to the lower grades of American turpentine oil. The rosin of this species is little, if at all, inferior to American and French rosins. The question of increasing the output of turpentine oil and rosin in India was fully dealt with by the Special Committee of the Indian Trade Enquiry on Gums, Resins and Essential Oils. This Committee also dealt with Indian lac. The reports on these subjects, which were furnished to the India Office, have been published (see page 142).

The possibility of utilising the oleo-gum-resin of *Boswellia serrata* has also been investigated. It has been shown that the oil obtained from this product by steam distillation closely resembles turpentine oil and can be used in place of the latter in paint and varnish making, whilst the rosin forms an excellent substitute for ordinary American rosin.

Endeavours have been made to find an outlet in the United Kingdom for "thitsi," the Burmese black lacquer; but, owing largely to the climatic conditions obtaining here, the material does not dry so satisfactorily as it does in Burma.

Much attention has been devoted to the subject of essential oils used in perfumery and in medicine. Amongst the oils examined may be mentioned those of lemon grass, citronella, vetiver, Inchi grass, rusa, sofia, patchouli, palmarosa, fennel, dill, deodar and sandalwood. In certain cases the oils have been produced for export and, in reporting on these, recommendations have been made as to the quality best suited to the English market. Reference may be made here to the question of the production of thymol from Indian ajowan seed, which is dealt with more fully on page 234.

Drugs.—The opium of India has received close and

prolonged attention at the Imperial Institute. It was shown by detailed investigation that, contrary to previous opinion, the opium produced in the majority of the opium districts of India is as a rule sufficiently rich in morphia to render it suitable both for medicinal use and for the manufacture of morphia. Some specimens proved to be as rich, or even richer, in morphia than good Turkey and Persian opium. Therapeutic trials with selected specimens arranged by the Imperial Institute at St. Thomas's Hospital were entirely satisfactory, and trials of Indian opium for the manufacture of morphia and codeine were equally successful. The attention of the Government of India was drawn by the Institute before the war to the possibility of shipping opium to the United Kingdom for medicinal use. After the outbreak of the war, when Turkey opium had become scarce, the matter was again raised and eventually the Government of India allowed Indian opium to be exported for this purpose.

The investigation of the composition and therapeutic value of the various Indian aconites is, from the scientific point of view, one of the most important investigations which have been conducted for India at the Imperial Institute. As a result of researches extending over a number of years, the alkaloids have been isolated and their chemical characters determined by the Director and members of the Staff, whilst with the valuable co-operation of Professor J. T. Cash, F.R.S., of the University of Aberdeen, their precise mode of action and therapeutic value have been ascertained. It has been made clear that several of these alkaloids are valuable medicinal agents.

Other Indian drugs investigated include *Podophyllum Emodi*, which as a result is now included in the British Pharmacopœia ; *Hyoscyamus muticus, Datura Stramonium, D. Metel* and *D. fastuosa* as sources of the alkaloids atropine, hyoscyamine and scopolamine ; belladonna ; Strychnos seeds ; colocynth ; senna ; Derris root ; and recently *Artemisia brevifolia*, as a source of santonin, a drug which has increased greatly in price, having been virtually a Russian monopoly.

The question of the production of cinchona bark and the manufacture of quinine in India was dealt with by the

Special Committee of the Indian Trade Enquiry on Drugs, Tobacco and Spices, and the report on the subject which was furnished to the India Office has now been published (see p. 142).

Fibres.—Although India produces a quantity of cotton second only to that of the United States, the bulk of it is comparatively short and unsuited to the requirements of the Lancashire spinner. The various Provincial Departments of Agriculture have consequently experimented with introduced varieties and selected Indian cottons, with a view to the production of a longer staple. The Institute has assisted in this work by examining a large number (some 400 in all) of samples both of experimentally produced cottons and of the ordinary types, and reporting on their suitability for the English market. In certain of the cotton-growing regions this work has proved highly successful, and improved kinds are now being largely cultivated.

Of textile fibres, other than cotton, a large number have been examined, including flax, jute, Bimlipatam jute, *Sida rhombifolia* and *Urena lobata* fibres. Regarding Bimlipatam jute the Institute demonstrated that this fibre was the product of *Hibiscus cannabinus*, and consequent on this, considerable attention has been devoted to the plant in India and improved races have been established. A report on jute, prepared by the Special Committee of the Indian Trade Enquiry on Jute and Other Fibres, has been published (p. 142).

The work of the Institute on Indian Silk which has been carried out by the Advisory Technical Committee on Silk Production has been referred to on p. 84.

Amongst cordage fibres examined and reported on may be mentioned sunn hemp, Mauritius hemp, plantain fibre, Sisal hemp and bowstring hemp.

Other fibres examined include flosses and various paper-making materials. As a result of detailed investigations conducted at the Imperial Institute, the Board of Trade expressed their willingness to allow Indian kapok to be employed in the place of Java kapok (which differs from the Indian material in its botanical origin) for use in marine life-saving appliances, provided that a definite and reliable standard of quality can be established and maintained.

Laboratory investigations at the Institute have shown that cotton stalks furnish paper pulp of fair quality, and, in view of the importance of the question to the cotton-growing industry, it was suggested that large-scale trials should be carried out with the material at a paper mill in India. Much attention has also been devoted to the question of utilising the vast quantities of bamboos existing in India for paper-making, and a comprehensive article, summarising the whole position, was published in the quarterly "Bulletin."

Tanning Materials.—The Institute has investigated a large number of the tanning materials which occur in India, including myrobalans, babul pods, mangrove bark and other well-known materials, as well as others which are little known outside India. In connection with the production of the timber of *Shorea robusta* and *Terminalia tomentosa*, large quantities of bark accumulated, and as these barks contain a fair amount of tannin the Indian Forest Department considered that they might be utilised for the manufacture of tanning extract. The extracts produced, however, were too strongly coloured, and at the request of the India Office an exhaustive investigation was conducted at the Imperial Institute with a view to ascertaining whether the extracts could be decolorised without loss of tannin. A new process was devised by the Institute for this purpose, and was tried at the Indian factory with promising results. It was, however, considered in India that it would be more profitable to manufacture mangrove extract. Much assistance was subsequently given by the Institute to the Government extract factory at Rangoon, and a series of extracts made there under the supervision of a practical expert was examined. They proved to be unsuitable for use in the United Kingdom without further treatment, and suggestions for their improvement were made.

Examination of the pods of *Cæsalpinia digyna* at the Institute showed that the husks were of special value as a tanning material, and several British firms who desired to obtain supplies of the pods were placed in communication with the Indian authorities. Enquiries in India indicated, however, that the wild pods could be obtained only in small

quantities and at an excessive cost, so that an export trade could be established only by cultivating the plant on a large scale.

In connection with an enquiry on the marketing of Indian myrobalans conducted by the Special Committee of the Indian Trade Enquiry on Hides and Tanning Materials, the report on which has been published (see p. 142), it was suggested to the Indian authorities that an investigation should be made as to the tannin content of the fruits of different varieties. Earlier examination at the Institute of a large number of commercial samples of myrobalans had shown that the amount of tannin present varies considerably, and it was desirable therefore to ascertain whether this is due to the variety of tree or to the locality in which the fruits are grown. In accordance with the Institute's suggestion, 37 samples, representing the fruit of different varieties of *Terminalia Chebula* and related species from various localities, were subsequently received from the Forest Department for examination and are at present under investigation.

Timbers.—The work conducted by the Institute on Indian timbers has included an enquiry as to the suitability of Pyinma wood for gun stocks, practical trials being conducted, by arrangement, at the Royal Arsenal, Woolwich ; an investigation of the mechanical properties and working qualities of Indian walnut, which was found to be suitable as a substitute for American walnut ; the suitability of certain Indian cedar woods for pencil making and of the Himalayan spruce for match making ; whilst a large series of Mysore timbers was received with a view to finding a market for them in this country.

In connection with the Indian Trade Enquiry, the Timbers Committee of the Institute prepared a report on Indian timbers suited for use in this country, apart from teak and others already established on the market. The report was transmitted to the Government of India and subsequently published in the series of Indian Trade Enquiry Reports (see p. 142). The Committee has also dealt with Burma woods suitable for the English market ; Indian oaks for use in place of oak imported from foreign countries ; and practical trials have been arranged to

determine the suitability of Indian gurjun and sundri woods for motor-body building, and of Indian haldu for making boot-lasts.

Minerals.—The following list of some of the Indian minerals examined indicates the varied scope of the work in this direction conducted at the Institute : coal, lignite, asphalt, graphite, mica, asbestos, steatite, talc, kaolin, cement-making materials, pottery clays, sands for glass-making, garnet, corundum, zircon, samarskite, monazite, titanium ore, bauxite, galena, molybdenite, tungsten ore, manganese ore, iron ore and pyrrhotite. In addition, some hundreds of specimens collected by the Gwalior Mineral Survey were fully reported on.

The composition and quality of Indian coal has formed the subject of several extensive and important reports. In all some 95 samples from the various Indian coal-fields have been examined.

In connection with a survey of Indian deposits of manganese ore, the Institute examined and reported on the samples collected, amounting to over 80 specimens, and the results, which were published both in this country and in India, have constituted the chief source of information regarding the composition of the various deposits.

Special mention may also be made of the investigations on Indian bauxites, for use as a source of aluminium and as a filtering agent in certain industries, and on cement-making materials. In both these instances commercial developments have followed.

Other Products.—Of products not included in the foregoing groups, which have been investigated at the Institute, reference may be made to cigar, pipe and other types of tobacco ; rubber, including Para, Castilloa, Ceara, Ficus and various lesser known kinds ; dyestuffs ; chank shells, used in India for making bangles and other small articles ; hides and skins ; and casein. In connection with Indian hides and skins the Institute was able, during the war, to introduce them to the notice of users not only in the United Kingdom but also in the various Dominions, and a report on the subject by the Special Committee of the Indian Trade Enquiry on Hides and Skins, which was furnished to the India Office, has been published

(see p. 142). Arising out of the examination of Indian casein, a special research was made on methods of estimating the amount of fat in casein and the results were communicated to the Society of Chemical Industry as well as to the authorities in India.

Indian Trade Enquiry.—In 1916 the Secretary of State for India requested the Imperial Institute Committee for India to enquire into and report on the possibilities of extending the industrial and commercial utilisation of Indian raw materials in the United Kingdom and elsewhere in the Empire. Special Committees were appointed to deal with the more important groups of Indian raw materials, to consider the results of investigations and enquiries already conducted at the Imperial Institute, and to obtain the views of leading merchants, manufacturers, and other users of the raw materials of India.

The Committees were constituted as follows :

Jute and other Fibres.—Sir Charles H. Armstrong; George Bonar, Esq.; Sir R. W. Carlyle, K.C.S.I., C.I.E.; Wyndham R. Dunstan, Esq., C.M.G., LL.D., F.R.S.; G. C. Hodgson, Esq.; J. A. Hutton, Esq.; Sir C. C. McLeod; George Malcolm, Esq., C.B.E.; Prof. J. A. Todd; Sir Francis Younghusband, K.C.I.E.; Dr. S. E. Chandler (Secretary).

Food Grains.—George B. Allen, Esq.; Sir Charles H. Armstrong; Sir J. P. Hewett, G.C.S.I., K.B.E., C.I.E.; A. E. Humphries, Esq.; the Right Hon. R. E. Prothero, M.P. (now Lord Ernle); Sir Marshall F. Reid, C.I.E.; Dr. T. A. Henry (Secretary).

Resins and Essential Oils.—Sir Harvey Adamson, K.C.S.I.; A. Yusuf Ali, Esq.; A. Bigland, Esq., M.P.; F. W. F. Clark, Esq.; Wyndham R. Dunstan, Esq., C.M.G., LL.D., F.R.S.; Lieut.-Col. S. H. Godfrey, C.I.E.; Sir James R. Dunlop Smith, K.C.S.I., K.C.V.O., C.I.E.; Dr. T. A. Henry (Secretary); H. J. Jeffery, Esq. (Assistant Secretary).

Drugs.—Sir Harvey Adamson, K.C.S.I.; A. Yusuf Ali, Esq.; Wyndham R. Dunstan, Esq., C.M.G., LL.D., F.R.S.; Lieut-Col. S. H. Godfrey, C.I.E.; Sir Edward Rosling; Dr. T. A. Henry (Secretary); H. J. Jeffery, Esq. (Assistant Secretary).

Oilseeds.—George B. Allen, Esq.; Sir Charles H. Armstrong; A. Bigland, Esq., M.P.; Sir J. P. Hewett, G.C.S.I., K.B.E., C.I.E.; J. W. Pearson, Esq.; Sir Marshall F. Reid, C.I.E.; Dr. T. A. Henry (Secretary).

Timber and Paper Materials.—Sir R. W. Carlyle, K.C.S.I., C.I.E.; Wyndham R. Dunstan, Esq., C.M.G., LL.D., F.R.S.; Lewis Evans, Esq., F.S.A., F.R.A.S.; Sir C. C. McLeod; Lawrence Mercer, Esq., C.I.E.; Graham P. Spicer, Esq.; Dr. S. E. Chandler (Secretary).

Hides and Tanning Materials.—Sir Harvey Adamson, K.C.S.I.; A. Yusuf Ali, Esq.; Sir W. Earnshaw Cooper, C.I.E.; C. W. Dawson, Esq.; Sir H. P. Densham, K.B.E.; Wyndham R. Dunstan, Esq., C.M.G., LL.D., F.R.S.; Lieut.-Col. S. H. Godfrey, C.I.E.; Sir Cecil W. N. Graham; W. L. Ingle, Esq.; Sir Henry Ledgard; C. J. Longcroft, Esq.; Samuel Millar, Esq.; Sir E. Penton, K.B.E.; H. Brown, Esq. (Secretary).

The following Reports furnished by the Special Committees to the India Office have been published: Hides and Skins; Oil Seeds; Rice; Timbers and Paper Materials; Jute and Silk; Lac, Turpentine and Rosin; Cinchona Bark and Myrobalans. These Reports contain important information and recommendations regarding the extension of the industrial and commercial utilisation of Indian raw materials, as well as statements, prepared at the Imperial Institute for the use of the Committees, on the general commercial position of each commodity.

SUMMARY OF INVESTIGATIONS CONDUCTED FOR THE COLONIES, PROTECTORATES, ETC.

The following is a brief sketch of some of the principal work which the Institute has done for the Colonies, Protectorates, etc.

In connection with its operations for the development of the natural resources of the Empire, the Imperial Institute has examined a very large number of raw materials from the Colonies and Protectorates, of which details

under different heads have been given in previous sections. These materials have been chiefly received from the technical departments of the respective Governments or from firms or individuals overseas, and as the result of their examination a large amount of information has been acquired and communicated to the countries concerned as to the value and commercial possibilities of these materials.

The information now on record regarding many of the raw materials of the Colonies, their nature and uses, is largely the result of the work of the Imperial Institute. This is generally acknowledged. One instance may be given. In 1915 the Colonial Office appointed a representative Committee to report on the trade in oilseeds and especially the palm oil and palm kernel trade of West Africa. The report of this Committee includes the following reference to the Imperial Institute :

" They (the Committee) consider it advisable that the Agricultural and Forestry Departments of the West African Colonies should take measures for the careful investigation of the properties of the several varieties of oil palm in each Colony, and of the best methods of cultivation of the species which are considered most suitable for economic purposes, *i.e.* for the production of palm oil and of palm kernels. These measures should be taken in co-operation, on the scientific and technical side, with the Imperial Institute, by which admirable work has been done in the past in connection with the oil palm, and to which much of the existing knowledge of the palm and its economic products is due."

Much assistance has been rendered by the Institute to the Colonies and Protectorates in connection with experiments which have been made locally with the object of improving the production and preparation of existing raw materials of the country or of introducing new products for cultivation. In a number of cases these experiments have led to the establishment or improvement of important industries in the various countries. Some of these are referred to in the Memorandum entitled

"Assistance rendered by the Imperial Institute in the Establishment of Industries Overseas" (p. 189).

In a number of cases raw materials received for examination at the Imperial Institute are sent by Government officers on their own initiative. This fact illustrates the need which exists for a central organisation like the Imperial Institute which deals systematically with such problems for all parts of the Empire and is in a position to give trustworthy advice and information on the basis of the results of examination and technical trial in its laboratories, and of communications with manufacturers, merchants and commercial experts in this country.

It is obvious that the operations of the Imperial Institute for the Colonies could easily be extended, but as the volume of work which is received automatically is more than the present staff can cope with, it would be inexpedient for the Institute under present conditions to initiate many additional enquiries which would result in a great increase in its work and in the demands made upon it for assistance.

It is not possible within the compass of a short report to give anything like a complete account of the assistance in many different forms which has been rendered by the Imperial Institute to the various Colonies. The following statement briefly indicates some of the principal investigations carried out. Little or no reference can be made here to the supply of technical and commercial information, which forms an important part of the services rendered by the Institute to Government departments, firms, etc., overseas, of which examples have been given in previous Memoranda.

Ceylon

Rubber.—In addition to the examination of many other samples of Ceylon rubber, over 500 samples specially prepared in connection with the Ceylon Rubber Research Scheme have been fully investigated in order to ascertain the most suitable method of preparation which will furnish rubber of the type required by manufacturers.

The vulcanising and mechanical properties of all these rubbers were determined and most of them were also examined chemically. Important investigations have also been carried out on a number of problems relating to the quality of plantation rubber.

Tobacco.—The Imperial Institute has assisted in the improvement of the tobacco grown in Ceylon, by the examination of native tobaccos and introduced kinds, including American, Turkish and cigar tobaccos (over seventy samples being reported on); by advising as to the best varieties to grow; by marketing trial consignments, and in other ways.

Fibres.—Samples of experimentally grown cotton have been examined and reports furnished as to their suitability for the United Kingdom market. Reports have been made on the quality and commercial value of the following fibres: plantain fibre, ramie, sunn hemp, Amomum fibre, kapok and Eri silk; also on talipot palm leaf stalks for paper-making.

Oilseeds.—The seeds, kernels and fat of *Bassia longifolia* were examined in connection with a general investigation of the suitability of Bassia fats for edible purposes. Candle-nut oil, castor seeds, coconut oil, ground nuts, oil palm nuts, soy beans, Sterculia fruits, and wild croton seed have also been reported on. During the war a market was found in the United Kingdom for copra previously taken by Germany and Austria, exporters in Ceylon being put in touch with firms in this country.

Essential Oils.—A detailed chemical examination was conducted of the various types of citronella, lemon grass and other aromatic grass oils produced in the island, and results of considerable practical interest were obtained.

Minerals.—A large number of minerals, collected by the Mineral Survey conducted in co-operation with the Imperial Institute, have been reported on, including monazite, thorite and the new mineral thorianite. Beach deposits of monazite sand are now being worked commercially; the Imperial Institute assisted in their development by examining the crude material, by conducting trials of concentrating machinery, and by selecting plant for working the sands. Other minerals examined include

plumbago, mica, gemstones, iron ore, molybdenite, zirkelite, limestone, glass sands, kaolin and laterite.

Miscellaneous.—Other products examined include cinnamon bark oil, coffee, tea-fluff as a source of caffeine, Para rubber seed cake, Datura leaves and seeds, coca leaves, orchella weed, box-wood substitutes, mahogany and sponges.

Mauritius

Essential Oils.—Much attention has been devoted in Mauritius to the distillation of essential oils, and specimens produced experimentally have been examined at the Institute in comparison with the commercial products. These have included clove oil and clove leaf oil of good quality, containing a high percentage of eugenol; sandalwood oil of good quality; ylang-ylang oil; the oil of *Eucalyptus citriodora*; champac essence; and camphor oils obtained from different parts of the plant, some of which proved to be unlike ordinary camphor oil; this indicated that the camphor plants in Mauritius are not of true type, and it was recommended that fresh seed be obtained from a country which is known to possess trees yielding typical camphor oil. The eucalyptus oil was found to be suitable for certain special purposes.

Oils and Oilseeds.—Reports have been made on ground nut oil, linseed, castor seed, candle nuts, and illipe oil obtained from the kernels of *Bassia latifolia.* All these materials were of satisfactory quality and would be readily saleable in Europe.

Foodstuffs and Spices.—Products in this category which have been examined and reported on include tea; peas and beans; Leucæna seeds; dried sweet potatoes; sweet potato meal; cassava meal; maize flour; Canarium seed, the kernels of which would be suitable as dessert nuts; pimento; cloves; cinnamon bark; nutmegs; and mace.

Other Products.—Other products reported on include kapok, Sisal hemp, cotton, Euphorbia resin, Canarium resin, tobacco, logwood, divi divi pods and timbers. The timbers represented ten different species, and detailed tests of their mechanical properties and working qualities

were carried out in order to determine their suitability for different purposes. Samples of locally produced yeast have also been investigated and a report furnished on the suitability of the material for the production of alcohol from molasses.

Practical tests have been made with various clays in order to ascertain whether they could be used in Mauritius for brick- and tile-making, and sample bricks made in the laboratories of the Imperial Institute accompanied the report on the subject furnished to the Mauritius authorities.

Seychelles

Essential Oils.—Regular and systematic assistance has been rendered by the Imperial Institute in connection with the development of the essential oil industry, which is now well established. Many such oils have been investigated and commercially valued, including oils of cananga, cardamoms, cinnamon bark, cinnamon leaves, citronella, clove leaves, lemon grass, *Ocimum viride*, *O. basilicum*, *O. gratissimum*, patchouli, Mozambique orange, bigarade, and *Vitex trifolia.* Investigations and trial distillations have been made of ajowan seed, clove leaves and vetiver root in order to determine the yield and quality of the oils obtainable. The demand for various oils has been ascertained and names of likely purchasers supplied to the Colony. The oil of *Ocimum viride* was shown to be a valuable source of thymol and consignments have been sold through the Imperial Institute to manufacturers in the United Kingdom.

Hats and Plaits.—At the request of the Imperial Institute specimens of hats and plaits, made from local materials, were forwarded in order to determine their suitability for use in the British hat-making industry. As a result trial orders for plait were procured from Luton firms and from Australia. A conference was held at the Institute, attended by the Governor of Seychelles and representatives of Luton Chamber of Commerce, at which the possibilities of Seychelles plaits were fully discussed. The market for Seychelles plaits will depend on these being

able to compete in price with supplies from elsewhere and on sufficiently large and regular production.

Miscellaneous.—Other products examined have included cotton, kapok, starch from fruit of bread-fruit tree, dried bananas and banana flour, cinnamon, vanilla, citrate of lime, Para rubber, Ficus rubber, Vahea (Landolphia) rubber, gutta-percha, orchella weed, tanning barks, tobacco, palm fruits, papaw juice, drugs, sponges, mother-of-pearl shells, soils, coral, laterites, guano, phosphate rock, limestone, bauxite and other minerals.

An investigation was carried out in conjunction with trade experts on the possibility of manufacturing vanilla extracts for export. Information and advice were given also on the cultivation of cloves, camphor, rubber and cinchona, and on the utilisation of explosives for breaking up hard sub-soil in coconut plantations.

St. Helena

Fibres.—Some years ago the Imperial Institute assisted in the re-establishment of the New Zealand hemp industry in St. Helena. Samples of the earlier commercial shipments to this country were examined in comparison with fibre from New Zealand and suggestions were made for improving the quality of the material. Particulars were also supplied as to the trade in the fibre, methods of preparation, names of makers of suitable machinery and related matters. For some years the fibre has formed the principal export of the Colony.

During recent years the Institute has carried out investigations and furnished advice on a number of important questions connected with the fibre industry, including the following: The possibility of utilising the waste pulp as a source of alcohol and paper and as a manure and a source of potash; and the quality of ropes made in the Colony from the fibre and the possibility of their finding a remunerative market in the United Kingdom.

An important industry which was introduced in order to give an occupation to women and girls in the island is the making of lace. For this purpose flax yarn has had to be imported, and attention has been given to the possi-

bility of utilising local fibre. The Institute was able to show that even if New Zealand hemp could be produced of sufficient fineness for lace-making, it would not be so suitable as flax on account of its inferior wearing properties. Information was also supplied regarding the possibility of growing flax in the island, and it was recommended that, owing to the cost of production and other considerations, it would be preferable to spin yarn from imported fibre, which would enable the lace to be produced at a cheaper rate than if the yarn itself were imported.

Other fibrous materials examined and reported on include Mauritius hemp, and a so-called "thatching grass." The latter was investigated as a paper-making material, and was shown to be suitable for the purpose. The characters and commercial value of cotton produced in the island have also been reported on.

Miscellaneous.—Cinchona was introduced into St. Helena many years ago, and the trees were allowed to become neglected, yet, even so, bark which was recently examined at the Institute proved to be of good quality and quite suitable for the manufacture of quinine or for druggists' use. Consignments similar to the material examined would find a ready market in London.

Amongst other materials investigated may be mentioned castor seed, a lichen for use as a dyestuff, and manganese ore, whilst information has been furnished regarding the utilisation of the prickly pear.

Federated Malay States and Straits Settlements

Rubber.—Assistance was rendered by the Imperial Institute in the early stages of the rubber planting industry of Malaya by examining many samples of rubber, prepared experimentally from cultivated Para trees, in order to determine their composition and commercial value. The results were of particular interest, as proving that Para rubber of high quality was obtainable from cultivated trees in Malaya. In addition many samples of "wild" rubber from Malaya were investigated. More recently, detailed investigations have been made of Para rubber prepared by a special process for comparison with that obtained by the ordinary methods.

Specimens of the various kinds of gutta-percha obtained from species of Palaquium, Bassia and Dyera, in the Straits Settlements, have been examined and their commercial values ascertained. On the basis of the results of the chemical examination of the material and of technical trials conducted for the Institute by manufacturers, it was possible to make recommendations as to the species which should be employed in the establishment of extensive plantations. Gutta-percha obtained from trees in Perak has also been examined and reported on.

Oilseeds.—The question of finding a use for the large quantity of Para rubber seeds produced in the plantations has been fully investigated at the Institute. It was found that the kernels of the seed yielded about 50 per cent. of a drying oil, and samples were submitted for technical trials to a number of manufacturers using this type of oil. The results showed that, although somewhat inferior to linseed oil for paint and varnish making, Para rubber seed oil could be employed as a substitute, particularly when linseed oil was high in price. It would also be suitable for the manufacture of soft soap and possibly also for the manufacture of rubber substitutes. Oil obtained from a trial consignment of about 26 tons of the seed sent to this country in 1917 was sold at £50 per ton, with linseed oil at £60 per ton, whilst more recently oil prepared in Malaya sold at prices even more nearly approximating to that of linseed oil. Feeding trials with the cake left after the expression of the oil from the seeds were arranged for by the Institute in this country and the results clearly established its value as a food for cattle.

The planting of the African oil palm, which has proved so successful in Sumatra, has now been commenced in the Federated Malay States, and in this connection information has been supplied regarding machinery suitable for preparing palm oil and for cracking the nuts.

Other oils and oilseeds dealt with include minyak surin, a solid fat suitable for candle- and soap-making, and illipe nuts.

Fibres.—Amongst fibres examined and reported on as to their commercial value may be mentioned Sisal hemp, Mauritius hemp, Sansevieria fibre, roselle fibre,

banana fibre, Nipa fibre, arrowroot fibre and floss. Lalang grass, which is a serious weed in Malaya and covers large areas, has been investigated as a source of pulp for paper-making, with satisfactory results.

Other Vegetable Products.—Reports have been furnished as to the commercial value or industrial uses of the following products: beans, banana flour, cassava root, patchouli and citronella oils, cloves, cinnamon bark, camphor and camphor oil, coca leaves, cocaine, morphia, cassia leaves, gum benzoin, dammar resin, Garcinia resin, gambier leaves and twigs, mangrove extract, annatto and agar agar.

Minerals.—Special attention has been devoted at the Institute to the investigation of the alluvial deposits in which tinstone occurs, with a view to ascertaining the presence of any other constituents likely to be of commercial value. A large number of concentrates have been examined and amongst the important economic minerals observed, in addition to tinstone, are monazite, wolframite, zircon and rutile. Other minerals examined include strüverite, a rare mineral containing tantalum; manganese ore; lead-tin concentrate; auriferous quartz; mica; corundum; garnet; coal; oil shale; kaolin; building stones and cement-making materials.

Hong Kong

A large part of the work carried out for Hong Kong has consisted in the examination of products which enter the Colony in the course of trade with Southern China, and regarding which information was desired by importers as to their uses and commercial value. In other cases the products have been grown experimentally in the Colony. Amongst oils and oilseeds examined and reported on may be mentioned candle nuts, Chinese wood oil, ground nut oil, hemp seed, soy beans and oil, tea seed and tea seed cake. The last-named material was found to contain saponin and a use was found for it in this country as a vermicide for dressing lawns. Foodstuffs dealt with include tea, ginger and various pulses. Several essential oils have been examined, including camphor oil, rose oil, citronella oil, peppermint oil, sandalwood oil

and the oil from Amomum fruits. Other materials reported on include silk, tobacco, medicinal plants, the barks of Chinese wood oil trees and the candle nut tree, Phyllanthus leaves and gall nuts as tanning materials, cow glue, fish glue and leather.

North Borneo

Sago.—Considerable assistance has been rendered by the Institute to North Borneo in connection with the development of the sago industry. The results of the examination of samples of sago pith and sago refuse at the Imperial Institute show that the native method of extracting starch from the sago palm is very wasteful and that a mechanical method could probably be used with advantage. Enquiries were therefore made as to the possibility of obtaining machinery for the extraction of the starch which would be suitable for use in Borneo, and specimen logs of the palms were supplied to two firms for trial. As a result proposals and estimates for an experimental plant were furnished. Samples of pearl sago have also been examined and information furnished as to the prospects of selling sago in Europe direct.

Kaolin.—As a result of technical trials carried out at the Institute it was found that clay from Tawao was suitable for the manufacture of buff-coloured pottery and for building bricks.

Tobacco.—A detailed examination was made of samples of tobacco leaf from plants sprayed with lead arsenate to protect them from insect attack, and also of cigars made from this leaf, with a view to ascertaining whether the amount of arsenic present was sufficient to be injurious. Tobacco attacked by insect pests has also been examined and methods of control suggested after consultation with experts. The value of a preparation which it was proposed to use as an insecticide on tobacco estates was determined and information furnished as to its possible effect on the burning qualities of the leaf. Detailed technical information regarding the manufacture in Borneo of nicotine and nicotine extract for use as an insecticide was also supplied.

Candle Nuts.—The kernels of these nuts would be

readily saleable as an oilseed if available in quantity, and detailed information as to the methods of preparing them for export was supplied by the Institute.

Locusts.—In connection with a recent attack by locusts in Borneo, measures of control were suggested in consultation with an expert. Specimens of the insects were obtained and arrangements made for their identification.

Miscellaneous.—Other products examined include iron ore, cotton, kapok, fibrous bark (as a paper-making material), fig bananas, " katiau " seeds and oil, gum, " siria " rubber and gutta jelutong.

UGANDA

Fibres.—Much attention has been devoted by the Institute to the question of cotton-growing in Uganda, now the most important industry in the country. More than 100 samples of cotton, either grown experimentally or representative of commercial consignments, have been examined and reported on, and advice has been given as to the kinds most suitable for the English market. The possibility of utilising the wild silk produced by species of Anaphe has been fully investigated in conjunction with the Imperial Institute Committee on Silk Production, and arrangements are now being made for large-scale trials by manufacturers in this country. Amongst numerous other fibres examined and reported on may be mentioned Sisal hemp, Mauritius hemp, flax, jute substitutes, various wild fibres utilised by the natives, and the floss or silk-cotton of species of Bombax and Calotropis. The suitability of elephant grass, which occurs in large quantities in the Protectorate, for use in paper-making, has been demonstrated by means of laboratory experiments and trials on a commercial scale. The question of the commercial production of the pulp in Uganda has also been fully considered.

Foodstuffs.—Assistance has been rendered to the Agricultural Department in experiments for improving the quality of the coffee produced in the Protectorate. A large number of different varieties of coffee have been examined and commercially valued and the kinds most likely to find a market in Great Britain determined.

Other foodstuffs and related products examined include cocoa, tea, sugar, wheat, and starch and flour prepared from sweet potatoes, cassava, yam beans, arrowroot and bananas.

Oils and Oilseeds.—The oils obtained from the seeds or fruits of many indigenous plants have been investigated and their commercial uses ascertained, whilst a number of experimentally-grown oilseeds have been examined and reported on. Included in this class of products are the seeds of species of Balanites, Carapa, Croton, Sterculia and Monodora, Pycnanthus fruits and mace, oil palm fruits, shea nuts, Ceara rubber seed, castor seed and linseed. Beeswax prepared by natives from the combs of indigenous bees has also been examined.

Other Products.—The rubber of wild plants, including species of Clitandra and Landolphia, and of cultivated Funtumia, Ceara and Para trees has been examined and reported on. More than seventy timbers occurring in the forests of Uganda have been investigated and their working qualities ascertained. These included several new timbers of marketable quality. Amongst other vegetable products examined and reported on are tobaccos, gum arabic, elemi resin, lemon grass, and tete grass oils, tanning barks, coca leaves, betel nuts, Stramonium leaves and seeds, and numerous native medicinal plants.

The minerals investigated include iron ores, gold ore, pyrrhotite, graphite, mica, asbestos, kaolin, limestone, asphalt. crude soda and a series of tile-making materials.

Kenya

Fibres.—The production of Sisal hemp is now one of the major industries in the Colony, the fibre being recognised as of high grade, whilst in recent years the growing of flax has also become of importance. The assistance rendered by the Institute to both of these industries has included the examination of samples produced experimentally or representative of commercial consignments and the supply of information to prospective planters regarding the localities, soil and climate suited to the crops, and the best methods of cultivating the plants and of preparing the fibre. Special attention has been devoted to the

question of introducing machinery for the preparation of Sisal hemp. Other fibres examined and reported on include several species of Sansevieria, Mauritius hemp, sunn hemp, ramie, banana fibre, baobab, Triumfetta fibre, various flosses, and silk of different kinds.

A large number of cottons, mostly produced in the course of experiments conducted with a view to improving the cotton-growing industry of the Colony, have been examined and reported on. Much attention has also been devoted to ascertaining the suitability of various materials for use in paper-making. The East African bamboo was shown to furnish a high-class paper, and, as a result of this work, the Government are now offering concessions for cutting bamboos in certain areas with a view to establishing a paper pulp industry in the country. Experiments with wattle wood demonstrated that it could be utilised, preferably in conjunction with some other material such as "spent" wattle bark, for the manufacture of strawboard, whilst other promising materials examined are Neoboutonia wood and papyrus.

Foodstuffs.—Some years ago attempts were made to encourage the native cultivation of beans for export. Various kinds were grown and the beans obtained were examined at the Imperial Institute in order to determine their suitability as human food or as feeding-stuffs for cattle, and they were also valued commercially. The authorities in East Africa were put in touch with firms in this country who would be willing to take consignments of beans regularly. The export of beans is now well established, and is one of the chief minor industries of the country. Other foodstuffs examined and reported on include peas, lentils, barley, wheat and flour, coffee, tea, dill, coriander and citrus fruits.

Oils and Oilseeds.—The cultivation and export of oilseeds constitute an important industry. Amongst those investigated at the Institute may be mentioned castor seed, linseed, niger seed, ben seed, Calodendron seed and *Croton Elliottianus* seed. The oil from the last-named seed was found to have valuable medicinal properties, and, as a result of the work of the Imperial Institute, consignments of the seed have been purchased by a firm

of manufacturing druggists with a view to introducing the oil into medical practice in this country.

Minerals.—A detailed investigation of the soda deposit at Lake Magadi was carried out at the Imperial Institute previous to its commercial development. A large number of samples of soda, alkaline liquors, spring waters and rocks obtained from different parts of the deposits were examined in order to obtain definite information as to the quantity of sodium carbonate in the lake crust and the possibility of its replenishment. Other minerals investigated include iron ores, manganese ores, copper ores, coal, graphite, mica, diatomite and limestone.

Other Products.—Several different kinds of rubber have been examined, including Ceara, Landolphia and Mascarenhasia, and the gutta of species of Chrysophyllum. Amongst timbers investigated may be mentioned the East African cedar, one of the best substitutes for pencil cedar, Podocarpus, Ibean camphor tree and ebony. Wattle barks obtained from trees of various ages have been examined comparatively with a view to determining the best age at which to collect the bark for tanning, whilst tanning extract prepared in Kenya from the bark has also been investigated. The possibility of utilising waste wattle, olive and other woods as a source of acetone, charcoal and other products by distillation has been dealt with, and reports have been furnished on the results of extensive trials conducted in the laboratories of the Imperial Institute. Other vegetable products examined include tobaccos; lemon-grass oil; ajowan seeds and *Ocimum viride,* as sources of the antiseptic thymol; Eucalyptus oil; and dom palm nuts for use as vegetable ivory.

ZANZIBAR AND PEMBA

Foodstuffs and Spices.—The cultivation of cloves is the chief industry of Zanzibar and Pemba, which produce the bulk of the world's supplies. The Institute has assisted this industry by the examination of samples of cloves, by supplying information as to the cultivation and marketing of the product, and by reporting on the market values of clove leaf oil and clove stems. A detailed investigation was made of a number of soils from

clove plantations, in order to ascertain the connection between the condition of the soil and a disease of clove trees, which was causing considerable loss in certain parts.

Amongst food-grains examined and reported on may be mentioned rice; maize; various millets, including Sorghum, Eleusine and Pennisetum; cow peas; green gram; Dolichos beans; pigeon peas and Voandzeia beans.

Oilseeds.—The plantations of coconuts rank next in importance to the clove industry in Zanzibar. Copra produced in the island has been reported on, and information has been furnished regarding the cultivation of the palm and various pests that attack it. The characters and commercial values of the oils yielded by the following seeds received from Zanzibar have been reported on: Para rubber seed, sesame seed, kapok seed, purging nuts, ground nuts, ben seed, Telfairia seed, castor seed, and oil palm nuts. A report on the composition and manurial value of the residual cake of purging nuts was also furnished.

Other Products.—The composition and market value of rubber obtained from planted Para and Castilloa trees have been determined and also of that from the wild Mascarenhasia trees. Other vegetable products investigated include banana fibre, coir rope and matting, mangrove barks, tobacco, ylang-ylang oil, annatto, and Cæsalpinia seeds used in native medicine. Guano and gem-stones have also been examined and reported on.

NYASALAND

Tobacco.—The Institute has rendered much assistance in the establishment of tobacco growing in Nyasaland, which is now the most important industry in the country. A large number of tobaccos of different kinds were examined and their respective qualities reported on; information was furnished as to the varieties of tobacco in demand here and the methods of preparation and cultivation to be adopted; and the suitability of a large number of soils for tobacco growing was determined. The question of the marketing of Nyasaland tobaccos has been fully dealt with. A large amount of special information on this subject was collected and in 1914 a Conference was held

at the Imperial Institute, at which the following, among other matters, were discussed: the use of Nyasaland tobacco in the United Kingdom and elsewhere; the best method of marketing the product; the grading and packing of the product in the Protectorate; and the improvement of the crop. At the suggestion of the Imperial Institute the War Office altered the specification for the tobacco supplied to the Army so that tobacco of satisfactory quality grown from American seed in the British Colonies and Protectorates can be used as an alternative to American-grown tobacco. As a result of this work the market for Nyasaland tobacco in the United Kingdom was considerably extended.

Fibres.—By long-continued trial cultivation and selection experiments a special kind of cotton of American type, known in the market as Nyasaland Upland, has been evolved, and the industry is now of great importance to the country, ranking second only to the production of tobacco. The Institute assisted in this work by examining the cottons obtained each year in the selection experiments and by furnishing reports which served as a basis for the work of the following year. Over 100 different cottons were thus investigated at the Imperial Institute, and their quality and commercial value determined.

In addition to cotton, the following fibres have been investigated: Sisal hemp, Mauritius hemp, Sansevieria, flax, species of Hibiscus, Sida, Triumfetta and Securidaca, broom corn, Anaphe silk and various grasses for paper-making.

Minerals.—A Mineral Survey of Nyasaland was conducted in connection with the Imperial Institute from 1906 to 1909, and a large number of minerals, rocks and concentrates were submitted to mineralogical and chemical examination in the laboratories and their commercial value reported on. Important deposits of iron ore, of good quality, were located, which may become of commercial importance in the future when transport and other conditions are favourable. A detailed investigation of the coal deposits in the neighbourhood of Lake Nyasa was made, and it was shown that excellent bituminous coal occurs near Mount Waller which could be utilised

as fuel and also for the production of coke and gas. Altogether sixty-eight samples of coal from various areas in the Protectorate were fully examined and their calorific value determined, whilst in promising cases coking tests and distillation trials were also carried out. Other minerals of importance collected by the Survey and examined at the Institute include mica, graphite, corundum, tin ore, argentiferous galena, gold concentrates and limestone.

Minerals collected by political officers and other Government officials have also been examined, and in recent years special attention has been devoted to the question of cement-making in the country. In this connection many samples of limestone and clay have been investigated in the cement-testing laboratories of the Institute, and reports have been furnished as to their suitability for the purpose, on methods of manufacture best adapted to the particular material, and on the local market for cement.

A large number of soils have been examined and their suitability for the cultivation of cotton and other crops reported on, whilst advice has been given as to the manurial treatment they require.

Other Products.—Foodstuffs examined include tea, maize, rice, Florida beans, velvet beans, chick peas and lentils. Amongst rubbers and allied products are Ceara, Ficus and Landolphia, and the resinous latices of various species of Euphorbia. Other vegetable products include cotton seed, ground nuts, palm fruits and the seeds of species of Croton, Trichilia and Jatropha, gum arabic, indigo and various materials used in native tanning.

TANGANYIKA

Since the establishment of a Department of Agriculture in Tanganyika in 1920, a number of materials produced in the Territory have been examined and reported on, whilst prior to this, in 1918, samples of cinchona bark were forwarded by the Administrator through the Colonial Office. The results of the investigation of the cinchona were very promising, and showed that bark of good quality could be produced in the Territory. A consignment of the bark was subsequently disposed of by the Imperial

Institute to a firm of manufacturing chemists in London.

A series of twenty-six cottons grown in various parts of the country has been examined and reported on in connection with a survey of the existing native cotton industry carried out by the Department of Agriculture. Advice was given by the Institute as to the kinds which should be used for selection and cultivation trials.

Samples of tobacco were tested chemically in order to determine their value for the manufacture of nicotine for insecticidal purposes and information was furnished as to the possibilities of growing tobacco in the Territory specially for the production of nicotine.

Other products examined and reported on include the leaflets of the wild date palm as a hat-making material, cassava, Amomum seeds, coal and corundum.

Somaliland

The products from Somaliland examined at the Imperial Institute have consisted chiefly of materials collected from wild plants and minerals. A complete series of gums, myrrh, frankincense, bdellium and similar products, the export of which constitutes an important part of the trade of the country, has been investigated. As a result of the work, the characters and commercial values of the products from the different species were definitely established.

Other vegetable products examined and reported on as to their composition and commercial value include tanning materials, such as wata leaves, the root bark of a species of Acacia, marra bark and jirma bark ; tobacco ; fibre of species of Sansevieria and of the Jalol acacia ; yebb nuts, used as a famine food in Somaliland ; and gusangus root, a soap plant.

The minerals investigated have included sub-bituminous coal ; crude petroleum ; bituminous materials ; rock salt, from which table salt could be readily prepared ; selenite ; iron ore and lead ore.

Nigeria

Oils and Oilseeds.—Much attention has been devoted by the Institute to questions relating to the preparation

of palm oil and palm kernels in Nigeria, particularly in regard to the relative values of the different varieties of the oil palm, to the production of oil of low acidity, and to the employment of machinery in the industry. In connection with the production of ground nuts, now a growing industry in Nigeria, a large number of different varieties have been reported on with a view to the selection of the best types for cultivation. Reports have also been made on the value of numerous oilseeds occurring in the Nigerian forests, including shea nuts, djave nuts, purging nuts, dika nuts, ikpan seeds, ben seeds, cheyi seeds, the seeds of species of Balanites, Ricinodendron, Pentadesma, Pentaclethra, etc.

Fibres.—Nearly 200 samples of cotton representing native and introduced varieties have been examined in order to determine those best suited for cultivation in the country, which is now one of the chief sources of cotton in Africa. Many of the fibres occurring in Nigeria have been examined and their commercial value ascertained, including jute, Sisal hemp, Mauritius hemp, coir, several species of Hibiscus, Honckenya, Triumfetta, Polygala, Sansevieria, plantain, etc. Various hat-making materials have been examined and the value of a number of grasses for paper-making determined.

Rubber.—Much assistance has been rendered by the Institute in connection with rubber production in Nigeria. The various "wild" rubbers were examined in order to determine their quality and commercial value; improvements were suggested in the native methods of preparation; and at a later stage information and advice were furnished in connection with the establishment and working of plantations of Para rubber trees. The rubbers reported on have included numerous samples of Para, Funtumia, Ceara, Landolphia, Clitandra and Ficus.

Tobacco.—Tobacco produced in Nigeria has been examined in order to determine its suitability for sale in this country, and information as to methods of fermentation, etc., has been furnished. A trial consignment of the tobacco was recently disposed of by the Imperial Institute in London.

Timbers.—A number of Nigerian timbers have been

investigated with a view to ascertaining their suitability for sale in this country. Mechanical tests and working trials have been made in the case of those woods which appeared promising.

Minerals.—The Mineral Surveys, conducted in the Northern and Southern Provinces in connection with the Imperial Institute, investigated the occurrence and distribution of minerals of economic importance and, in addition to other results, discovered (1) the important Udi coal-fields, and also large deposits of lignite, in the Southern Provinces, and (2) new tinstone areas and iron ore deposits in the Northern Provinces. The Udi coal-field is now being worked by the Government, and important developments in tin mining have occurred in the Northern Provinces. In all cases the materials collected during the surveys were examined at the Imperial Institute, and, where necessary, submitted to technical trials in order to determine their value and commercial possibilities.

Other minerals examined include lead-silver ores, blende, monazite sand, mica, kaolin, brick- and tile-making clays, limestones, potash salts, etc., as well as a large number of well borings obtained in the course of a search for petroleum in the Southern Provinces.

Miscellaneous.—Other Nigerian products reported on include cocoa, tea, rice, millet, maize, wheat, beans of various kinds, pigeon peas, Bambarra ground nuts, ginger, cassava, yams, dried bananas, etc.; gums from different species of Acacia and other plants; copals; dye-woods, native indigo; Acacia pods, mangrove barks and other tanning materials; lime fruit products; cinchona bark; vegetable ivory nuts; leather; ostrich feathers, etc.

Gold Coast

Foodstuffs.—The Imperial Institute co-operated with the local Department of Agriculture in the development of the cocoa industry of the Colony, which is now the largest producer of cocoa in the world. A number of samples prepared in different ways were examined, and on the basis of the results obtained recommendations were made for improving the preparation of the cocoa so as to render it suitable for use in the United Kingdom. Consignments

of selected cocoa were subsequently sold in London by the Imperial Institute, and as a result of the action taken an English firm of cocoa manufacturers sent out a representative to the Colony and afterwards established a buying agency there. There is now an established market for Gold Coast cocoa in the United Kingdom.

Other foodstuffs examined include maize, guinea grains, beans, cassava, arrowroot, dawa-dawa pods, N'kosoe nuts, chillies, pepper, allspice, etc.

Oilseeds.—In connection with a general survey of the oil palm industry of West Africa, the fruits, kernels and oil of a number of different varieties of oil palm occurring in the Gold Coast were examined and reported on. Advice was given as to methods of preparation of palm oil, including the use of suitable machinery. Amongst other oilseeds investigated may be mentioned Carapa seeds, abaku nuts, copra, Lophira seeds, Pentadesma seeds, Monodora seeds, purging nuts, neele seeds, kapok seed, kisidwe nuts, shea nuts, etc. The question of preparing an edible fat from shea butter is being investigated.

Fibres.—Over seventy different samples of cotton grown experimentally or produced by natives have been reported on. Many fibres have been examined, including coir, plantain, banana, pineapple, Dracæna, Hibiscus, Triumfetta, kapok, Funtumia floss and various hat-making materials.

Rubber.—The various "wild" rubbers occurring in the Gold Coast were examined in order to determine their quality and commercial value; improvements were suggested in the native methods of preparation; and at a later stage information and advice were furnished in connection with the establishment and working of plantations of rubber trees. The rubbers reported on have included numerous samples of Para, Funtumia, Ceara, Landolphia and Ficus, and also various gutta-like products.

Minerals.—The minerals investigated have included petroleum, bitumen and limestones, as well as 400 specimens of rocks, minerals, and concentrates collected by the Gold Coast Geological Survey.

Miscellaneous Products.—The gums yielded by different species of Acacia, Burkea, Combretum, etc., have been

investigated, and also a number of copals. Kola nuts, Zanthoxylum bark and Strophanthus seed have been examined, as well as various drugs used in native medicine. Other vegetable products reported on include mangrove barks, divi-divi pods, cinnamon bark, camphor, vetiver roots, tobaccos, native indigo and a series of forty-eight different kinds of timbers.

Sierra Leone

Fibres.—During a period of shortage of Indian jute some years ago, investigations were made by the Institute in order to ascertain the possibility of using various West African fibres as substitutes for that fibre. Among Sierra Leone fibres examined from this point of view were species of Hibiscus and Honckenya, and consignments of two of these fibres were sold through the Imperial Institute in order to test the market.

Other fibres investigated and reported on include Sisal hemp, Mauritius hemp, Sansevieria, Dracæna, pineapple, ramie, coir, Raphia bass, brush-making fibre from oil palm leaves, and baobab bark for paper-making. Various samples of cotton have also been examined.

Oils and Oilseeds.—Fruits of the variety of oil palm occurring in the Colony were examined in comparison with those occurring in other parts of West Africa. Reports have also been furnished on a number of oilseeds and oils, including the seeds of species of Lophira, Carapa, Pentadesma, Pycnanthus and Pentaclethra, gorli seed, po-yoak nuts, soy beans, castor seeds and piassava oil.

Foodstuffs.—Investigations were conducted with a view to improving the quality of Sierra Leone ginger, which is the third most important agricultural product of the Colony. Samples were examined and advice given as to the best methods of cultivation and preparation. Consignments prepared by the ordinary and improved methods were subsequently received, and the prices realised indicated the advantage of better preparation.

Other foodstuffs reported on have included cocoa, pigeon peas, various beans, cassava starch, guinea grains, etc.

Rubber.—The various "wild" rubbers occurring in

Sierra Leone were examined in order to determine their quality and commercial value, and improvements were suggested in the native methods of preparation. The rubbers reported on have included numerous samples of Funtumia, Landolphia and Ficus.

Essential Oils.—The volatile oil of *Ocimum viride* was shown to be a valuable source of the antiseptic thymol, and in this connection seeds were obtained from the Colony and distributed for cultivation in various parts of the Empire.

Miscellaneous Products.—Other products reported on have included mangrove bark, gara (a native dyestuff), copal, various native drugs, tobaccos, mahogany, pooli wood, African rosewood, umbrella wood and other timbers, monazite sand, iron ore, clays, soils, etc.

Gambia

Fibres.—Kapok from different places has been examined at the Imperial Institute and submitted to commercial valuation in order to ascertain whether the floss would be suitable for shipment to the United Kingdom in competition with supplies from other sources. Attention was drawn by the Institute to the market which exists for kapok seed as a source of oil.

Other fibres examined include cotton, jute, Hibiscus fibres, Urena fibre and other jute substitutes. It was shown that jute of excellent quality can be grown in the Gambia. The possibility of utilising palm-fibre from the Gambia in the British hat- and basket-making industries has been investigated.

Mangrove Bark.—The mangrove barks of the Gambia have been found to contain a low percentage of tannin and to be unsuitable for export to the United Kingdom or for the manufacture of extract. In these circumstances they are only of interest as a tanning material for local use.

Minerals.—A large number of clays were examined, and the most promising were submitted to technical trials. It was found that several of the clays would be suitable for use locally for brick- and tile-making and for earthenware. The results of the examination of a further series of clays and limestones showed that the clay could be used locally

for brick- and tile-making, and in conjunction with the limestone for cement-making, but that the limestone was not suitable for making agricultural lime.

Eight specimens of iron ore were suitable for smelting locally, but not for export. A number of aluminous minerals have been investigated in view of the suggestion that bauxite occurs in the Colony, but the results were not promising. Specimens of soils from different localities have been examined, and suggestions made in each case as to the manurial treatment required.

Miscellaneous Products.—The yields of oil from different varieties of ground nuts have been compared. Samples of castor oil seed have been examined and their value in the United Kingdom determined. Other products examined have included oil palm fruits, Ficus rubber, maize, guinea corn, oranges, Cynometra pods, Datura fruits, Daniella resin, rosewood and mahogany.

Cyprus

Essential Oils.—The distillation of essential oils is an important minor industry in Cyprus, the principal oil concerned being that of origanum, which is used largely in this country for perfuming soaps and for other purposes. The Cyprus origanum oil has been submitted to detailed investigation at the Imperial Institute, and has been shown to be exceptionally rich in carvacrol, a powerful antiseptic which can be used as a substitute for thymol. The ordinary oil darkens on exposure to light and air, which renders it unsuitable for light-coloured soaps, but a method was worked out at the Institute of refining the oil so as to yield a product which will remain almost colourless for long periods. Other essential oils whose characters and commercial value have been reported on include geranium oil, laurel oil, marjoram oil, juniper oil, the oil of *Ocimum viride*, sage oil, cumin oil, aniseed oil and otto of roses.

Foodstuffs and Spices.—Cyprus barley examined at the Imperial Institute was found to be of excellent quality and particularly suitable for malting purposes. Large quantities of barley are grown in Cyprus, and at one time it was exported to this country. Material equal in quality to that examined if shipped to this country would realise

high prices. A special variety of naked or skinless barley was also investigated, and although it was shown that it could not be employed for ordinary malting, it was considered that it might be used by distillers, and in any case would rank as a good class of feeding barley. Oats and oat straw, chick peas, vetch seeds, chickling vetch seeds, Prosopis beans, carobs and dried fruits have also been examined and reported on regarding their quality and market value, as well as various spices such as coriander, aniseed, black cumin and white cumin.

Tobacco.—Large quantities of cigarettes are made in Cyprus, mainly from imported Macedonian tobacco. In recent years the Agricultural Department has endeavoured to start a tobacco-growing industry in the island by experiments carried out in various districts. Many samples produced in this way have been examined at the Imperial Institute, and reports have been furnished indicating the defects they exhibited and containing recommendations for their improvement, particularly in relation to the method of curing.

Fibres.—Several fibres produced experimentally have been examined and reports furnished as to their quality whilst advice has been given as to methods of preparation, with a view to the production of improved material. These have included flax, Sisal hemp, Mauritius hemp and ramie.

The question of the improvement and marketing of Cyprus silk has received particular attention and a special sub-committee of the Imperial Institute Advisory Committee on Silk Production has dealt with the matter. The recommendations of the Committee for the establishment of a filature are now under the consideration of the Cyprus Government.

Cotton also has been dealt with, special attention being devoted to it by the Director in his Report on the Agricultural Resources of Cyprus presented to Parliament in 1905, whilst recently samples grown experimentally by the Agricultural Department have been examined and reported on.

Other Vegetable and Animal Products.—Samples of castor seed, ground nuts and Perilla seed have been

examined and reported on, the last-named having been grown from seed specially supplied by the Institute. The tanning value of several Acacia barks has been determined, as well as of sumach and shinia leaves. Other materials dealt with include squills, liquorice, gum labdanum, scrub oak timber, Persian berries, barberry, ostrich feathers, sponges and goat skins.

Minerals.—The characters and possibilities of marketing the following minerals have been determined: asbestos, magnesite, kaolin, terre verte, salt and copper ore.

West Indies

Jamaica

Minerals.—In connection with a proposal to establish cement works in the island, the Imperial Institute furnished information as to the suitability of samples of limestones for the purpose, and also advised on a number of technical and economic questions affecting the successful establishment of an enterprise of this character.

A series of ochres examined were not of sufficiently good quality to be profitably marketed in the United Kingdom, but a method of preparation was suggested whereby some of the materials might be rendered suitable for local use.

Investigations carried out at the Imperial Institute showed that the salt produced in the Turks and Caicos Islands is of excellent quality. A special question relating to the use of this salt for curing fish is under consideration.

Other minerals examined include copper and silver ores, lignite and tremolite.

Advice has been given by the Institute to the Government of the Colony in connection with proposals to develop the use of the radio-active mineral waters of the Island, and apparatus to enable the activity of the waters to be determined has been selected and supplied.

Essential Oils.—An investigation of wild pimento leaves showed that they contain an oil which would be of commercial value if available in quantity, and that a useful tanning extract could be prepared from the leaves as a by-product. Arrangements have been made by the Government of the Colony for the distillation of the oil

in co-operation with growers, and further investigations are being carried out by the Industrial Chemist in the island.

Miscellaneous Products.—Samples of tobacco have been investigated and endeavours made in communication with the Jamaica Agricultural Society to encourage the further production of cigar leaf for export. The suitability of mangrove bark for local use as a tanning material has been determined and the possibilities of exporting the bark or preparing an extract for export investigated. Henequen and Sisal fibres grown experimentally have been found to be suitable for sale in the United Kingdom, and offers to take charge of consignments transmitted to the Colony. Among other products investigated are the following: banana meal, Yucca fibre, opium, logwood, sponges, timbers and rubber.

Trinidad and Tobago

Minerals.—Considerable assistance was rendered by the Institute in the development of the principal minerals at present worked, viz. asphalt, manjak and petroleum. Samples of the manjak and bituminous minerals were examined and submitted to technical trials, as a result of which suggestions were made with a view to the preparation of products likely to be suitable for the United Kingdom market. Samples of crude petroleum obtained from trial wells have been examined. Other minerals examined include cement-making materials and iron ores.

Rubber.—Several collections of rubbers (Para, Castilloa, Funtumia and Landolphia) from trees growing on lands belonging to the Botanical Department and on private estates have been reported on, and information supplied as to their value in the United Kingdom.

Silk.—In connection with attempts made by the Imperial Institute to develop further sericulture in the British Empire, the possibilities in Trinidad have been investigated. Samples of mulberry silk, Eri silk and Trinidad wild silk have been examined, as a result of which a number of suggestions for further experiments in the Colony have been made.

Miscellaneous Products.—The Institute has co-operated

with the Botanical Department and later with the Department of Agriculture in the examination and valuation of products grown experimentally, *e.g.* cotton, Manila hemp, tobacco, coffee. Samples of ajowan seed and *Ocimum viride* seed have been supplied to the Department for trial cultivation as thymol-yielding plants.

A series of hat-making materials from Trinidad and Tobago received from the Department have been investigated in conjunction with the Luton Chamber of Commerce to determine their suitability for use in this country.

Among other products from Trinidad which have been dealt with at the Institute the following may be mentioned: cassava (conditions of formation of prussic acid), Canavalia beans, black-eye peas, vanilla, cocoa, Mauritia nuts, mango seed, avocado pear seed, copra, Omphalea seeds (including physiological trials of the oil), mora wood and mongoose skins.

Leeward Islands

Fibres.—In connection with experiments in cotton cultivation at the Botanic Station, Montserrat, a large number of samples have been examined at the Imperial Institute, and valuations obtained. Several samples of cotton and of agave fibre grown in Antigua have also been investigated and suggestions made for improvements in the method of preparation.

Rubber.—Considerable assistance was rendered by the Institute in connection with the introduction of rubber trees with a view to establishing a rubber-planting industry in Dominica. Samples of Castilloa, Funtumia and Para rubbers grown in the island were examined and their value determined. The results of this series of investigations showed that Para trees in Dominica would furnish rubber of excellent quality.

Drugs.—*Datura Metel* leaves received from Montserrat were found on examination at the Imperial Institute to contain a satisfactory percentage of the valuable alkaloids, scopolamine and hyoscyamine, and attempts are now being made to establish an export trade from the Colony.

Oilseeds.—The question of utilising the large quantity of seeds obtained as a by-product in the lime-fruit

industry has recently been investigated by the Institute in conjunction with the Government Chemist. The oil from the seeds has been found to be suitable for use in the United Kingdom for soap-making, etc., and information respecting its value for this purpose has been communicated to the Government of the Colony.

Minerals.—At the request of the Government Geologist a number of mineral specimens which he collected during a recent examination of the islands have been investigated and reports furnished as to their possible uses and economic value. These comprised supposed gold- and silver-bearing gravels, sands containing rare earth minerals, lignite and phosphate deposits.

Other minerals which have been examined are sand (Montserrat), phosphate (Redonda), mani (Dominica), molybdenite (Virgin Islands), and barium sulphate (Antigua).

Miscellaneous Products.—At the request of the Government experiment stations, a variety of products obtained in trials have been examined, some of which were proved to be suitable for the United Kingdom market, *e.g.* ajowan seed (Montserrat), shea nuts (Dominica), essential oils (Dominica), ground nuts (Montserrat), bay leaves (Dominica), cocoa.

Other products from the Leeward Islands examined at the Imperial Institute include beans (Montserrat), chillies (Virgin Islands), sponges (Virgin Islands), and gommier resin (Dominica).

Windward Islands

Foodstuffs.—At the request of the Imperial Department of Agriculture for the West Indies, detailed enquiries have been made by the Imperial Institute as to the possibility of extending the market in the United Kingdom for St. Vincent arrowroot, both as a foodstuff and also for various industrial purposes. Endeavours have also been made to find a market in this country for black velvet beans, which are largely grown in St. Vincent as a cover crop; they were, however, not saleable for human consumption, and recommendations were accordingly made as to the most suitable method of utilising them as a feed-

ing stuff for animals. Information was supplied as to the quality and commercial value of dried bananas prepared experimentally by the Agricultural Superintendent, St. Lucia, and offers were obtained from merchants to take trial shipments.

Fibres.—The possibility of Jippi-Jappa straw from Grenada being utilised in the British straw-hat making industry has been investigated by the Imperial Institute, in communication with the Luton Chamber of Commerce. Samples of cotton from St. Vincent, St. Lucia and Grenada have been reported on, and the cotton seed oil expressed at the Government Ginnery, St. Vincent, has been examined in order to ascertain its quality and commercial value.

Minerals.—Samples of hæmatite and copper ore from Grenada collected by the Government Geologist during a recent examination of the mineral resources of the Windward Islands were reported on. The hæmatite represented a high-grade iron ore, which would be readily saleable in the United Kingdom. Samples of clay from St. Vincent and a number of other mineral specimens from Grenada have also been investigated.

Tobacco.—Assistance has been rendered by the Institute in connection with experiments on tobacco cultivation in Grenada and St. Vincent, by the examination and valuation of samples of the leaf; suggestions for further experiments were forwarded to the Colony.

Miscellaneous Products.—Other products from the Windward Islands which have been examined at the Imperial Institute are: gru gru kernels and fat (Grenada), Vigna seeds (St. Vincent), sponges (St. Vincent), gommier resin (St. Vincent), and rubber (St. Lucia).

Barbados

Sugar-cane Wax.—Important investigations were undertaken by the Imperial Institute on behalf of the Government of Barbados in connection with the proposals to prepare wax from sugar-cane refuse.

In addition to supplying technical information to the Chemist in Barbados, the Institute arranged with manufacturers to carry out extraction trials of the wax on a

commercial scale, and made enquiries in various directions to determine the commercial value of the product. As a result an offer was obtained from a company to enter into contracts for the purchase of wax and to advance the money necessary for the erection of extracting machinery. This offer, however, was not acceptable in the Colony.

Mahogany Seed Oil.—In connection with proposals in Barbados to collect mahogany seed for the preparation of oil, samples of the seed were examined at the Imperial Institute and their value in the United Kingdom determined.

Manjak.—The suitability for technical purposes of manjak from the Scotland District has been investigated in communication with varnish makers, and experiments have been made with a view to purifying the material so as to render it more acceptable to British manufacturers.

Miscellaneous Products.—Samples of diatomite, cotton and cotton seed oil have also been examined.

Technical information and advice has been furnished by the Institute to the Government of Barbados on the manufacture of briquettes from loose coal for use on the Barbados Railway (including particulars of technical literature and names of engineers willing to carry out technical trials), and on methods of denaturing alcohol for industrial purposes.

Bermuda

Tobacco.—The Imperial Institute rendered much assistance in connection with the experiments in tobacco cultivation which were carried out for many years at the Public Garden. In addition to the examination and valuation of a large number of samples of tobacco produced in the experiments, suggestions were made by the Institute as to the lines on which the trials should be carried out and the method of preparing the leaf. The soils on which the tobacco was grown were also examined, and recommendations made as to the use of manures to render them more suitable for tobacco cultivation. Local materials (such as seaweed ash and sage bush ash) were investigated to determine whether they could be utilised as fertilisers for this purpose. With a view to improving

the quality of the tobacco produced the Imperial Institute also supplied samples of selected seed for trial.

Arrowroot.—At the request of the Government of the Colony, the Institute examined a number of products sold in the United Kingdom as Bermuda arrowroot, with a view to detecting adulteration, and made a detailed comparison of the quality and composition of St. Vincent and Bermuda arrowroots.

Miscellaneous Products.—Investigation at the Imperial Institute showed that liquorice roots from Bermuda would be saleable in the United Kingdom, and advice as to the best method of marketing the product was furnished. Other products examined include sponges, loofahs, lemon grass oil, bulbs of *Lilium Harrisii*, and rope used in the Colony.

Bahamas

Fibres.—Assistance was rendered by the Institute in connection with the cultivation of Sisal hemp, now an important industry in the Bahamas, by the examination and valuation of samples, and the supply of detailed information as to the possibilities of promoting an export trade with the United Kingdom.

Tobacco.—In connection with experiments in tobacco cultivation at the Botanic Station, a number of samples were examined and suggestions made for improving the soil and for further experiments with other varieties of leaf.

Rubber.—Specimens of rubber prepared from the Cryptostegia vine were of good quality. At the request of the Government, the amount of rubber which could be extracted from the stems of the plant was subsequently determined, in order to obtain data as to the feasibility of preparing rubber by this method in the Bahamas.

Water.—Eleven samples of water received from the Government were chemically examined in order to determine their suitability for drinking purposes.

Miscellaneous Products.—Other materials examined include Cascarilla bark, braziletto wood and logwood, cotton, mother-of-pearl shells, marl, coal, cave earth and seaweed ash.

British Guiana

Timbers.—The Imperial Institute has taken action with a view to developing the use in this country of the valuable woods with which the forests of the Colony abound. The Timbers Committee of the Institute selected from the specimens in the Exhibition Galleries a number of woods of promising character, and the Government of the Colony has been requested to forward a trial shipment of these in order that they may be brought to the notice of the trade. Arrangements have also been made for two British railway companies to carry out trials with mora and wallaba timbers from British Guiana for use as sleepers.

Specimens of cedar wood, white siruaballi, crabwood and duka were examined in communication with manufacturers in the United Kingdom in order to determine their suitability for the manufacture of cigar boxes. The Institute also arranged for selected samples of several British Guiana woods to be submitted to technical trial in British Government factories, with a view to their use for the manufacture of rifle stocks.

At present the Institute is undertaking, in conjunction with the Department of Lands and Forests, a comprehensive investigation to determine the possibility of British Guiana timbers being utilised for the manufacture of paper pulp.

Rubber and Balata.—A large number of samples of rubber from indigenous trees have been examined, as well as Para rubber from trees at the Government rubber station. The Para rubber was equal to good plantation grades from the East.

Considerable attention has also been devoted to the examination of balata and allied products, including a detailed investigation of the relationship between the brittleness of crude balata and the amounts of gutta and resin present in the material, a subject of importance in connection with its commercial uses.

Fibres.—Over fifty samples of cotton grown in the Colony have been examined from time to time and valuations supplied. In this connection cotton hybridisation

trials were carried out on lines suggested by the Institute, and proved successful. Investigations at the Imperial Institute have indicated that rice straw, mocca-mocca, wild ginger and sedge from British Guiana are promising materials for paper-making.

Miscellaneous Products.—Among other materials from British Guiana which have been examined, the following may be mentioned: Cokerite nuts, ivory nuts, logwood, tobacco, lignite, petroleum, quartz and clay.

British Honduras

Timbers.—In consultation with the Forest Officer of the Colony, the Timbers Committee of the Imperial Institute has enquired into the possibility of marketing in the United Kingdom the many British Honduras woods which are not already well known. Special enquiry has been made respecting the utilisation of the pine forests as a source of coniferous timber. Two series of British Honduras timbers are now being submitted to examination in order to determine their mechanical properties and working qualities.

Fibres.—Considerable assistance was rendered by the Institute in connection with the experiments in cotton cultivation carried out for a number of years at the Botanic Station, the cottons produced in the various trials being examined and valued. Samples of agave fibre and kapok grown experimentally have also been investigated, and detailed information has been supplied as to the prospects of agave and bromelia fibres being successfully prepared for export.

Tobacco.—The results of the examination of samples of tobacco has shown that a product suitable for the European market could be produced in the Colony, and the Institute suggested the appointment of a tobacco expert to assist in the development of the tobacco industry.

Oilseeds.—A detailed examination has been made of the oil obtained from the seeds of the cohune palm, which is very abundant in the Colony. Both the oil and residual meal would find a ready market in the United Kingdom, and, as a result of the publication of the results of this

investigation in the Bulletin of the Imperial Institute, many enquiries were received at the Institute from commercial firms in this country and elsewhere. Trials have also been made by the Institute with a view to obtaining a machine suitable for cracking the nuts, as this question is of importance in any attempts to utilise the nuts commercially as a source of oil.

Miscellaneous Products.—Other products from the Colony which have been investigated include cocoa, rice, sword beans, craboo bark, mangrove bark, soap berries, balsa wood, limestones and phosphate rock.

Falkland Islands

By-products of the Whaling Industry.—The Imperial Institute has carried out a number of investigations connected with the disposal of the by-products of the whaling industry of the Dependencies, which is now the most important in the world. Information, based on the results of the examination of specimens, has been furnished regarding the commercial value of the bones and skins of whales, of guano prepared from the carcase, and of ordinary whalebone.

Peat.—Much attention has been devoted to the question of the utilisation of the extensive peat deposits of the islands. Specimens of the peat have been examined and preliminary distillation trials, arranged by the Institute, have been carried out in order to determine the yields of charcoal, acetic acid, ammonia and oils. For the present, however, the peat would have to be disposed of as fuel chiefly in South America, and an exhaustive enquiry was made as to the possible markets for the material in that region.

Penguin Guano.—Samples of penguin guano, including specimens collected by the Government Geologist, have been examined in order to determine their quality and probable commercial value. The guano is inferior to Peruvian guano, and, in view of its moist condition, it could not be remuneratively shipped in its natural state. If, however, it could be artificially dried in the Colony, the dried material might be utilised as a filling material in the manufacture of compound manures.

Minerals.—A number of minerals have been investigated, including copper ore, quartz, bitumen, oil shale, sand for glass making and limestone.

Distillation trials carried out at the Imperial Institute with bitumen from the Falkland Islands showed that it gave a large yield of oil of promising character, and the Institute suggested that the deposits should be examined by a specialist with a view to ascertaining the quantity available.

The limestone was examined in order to ascertain whether lime, suitable for hardening the water of the Falklands, could be prepared from it. In this connection samples of water were also examined and a detailed report on the whole question was furnished. Water obtained from a spring, intended to supply the town of Stanley, was examined chemically and its suitability for drinking purposes reported on.

Fiji

Fibres.—Amongst fibres examined and reported on may be mentioned Sisal hemp, Mauritius hemp, bowstring hemp, ramie and jute. The Sisal hemp in particular was of good quality, and, as a result of the favourable report by the Institute, the Agricultural Department was able to recommend the cultivation of the fibre in certain areas of the islands.

With regard to cotton, which is at present attracting attention in Fiji, the Institute has examined samples grown experimentally and has advised regarding a scheme for establishing a cotton-growing industry in the islands.

The fibrous stems of the vau tree (*Hibiscus tiliaceus*) have been investigated in order to determine their suitability for paper making, and it was found that they gave a good yield of pulp, which could be used for the manufacture of wrapping paper.

Foodstuffs.—Cocoa, of excellent quality, grown in Fiji, has been reported on, and this crop is now being produced on a small scale in the islands. Other foodstuffs dealt with include tea, cloves, ginger, lemons, arrowroot and cassava starch.

Oilseeds.—Ground nuts and castor seed grown experimentally were of good average quality, and the cultivation of these crops could be recommended. Oil obtained in Fiji from the seeds of *Calophyllum inophyllum*, an indigenous tree, was found to be suitable for soap-making, but it was advised that it would be preferable to export the seeds, as, with the more careful preparation of the oil which would be possible in Europe, an oil suitable for edible purposes might be produced and so increase the value of the product.

Essential Oils.—Oil distilled at the Institute from the bark of an indigenous species of cinnamon was found to differ from ordinary cinnamon bark oil, and, in view of its pleasant odour, which was similar, but superior, to oil of sassafras, it would find a use in perfumery, especially for scenting toilet soaps. Another new oil, first examined at the Institute, and also found to be suitable for perfuming soaps, was that obtained from a grass, *Cymbopogon coloratus.* A small consignment of this oil prepared in Fiji was sold through the Institute. Other essential oils examined and reported on include vetiver oil and a variety of bay oil.

Other Vegetable Products.—The resin of *Dammara vitiensis* was found to resemble in character ordinary Manila copal, and it was suggested that it should be marketed as "Fiji copal," whilst advice was given as to the method of cleaning and grading the material before export. A sample of mangrove extract prepared in Fiji proved to be similar to ordinary mangrove cutch, and could be used, like the latter, for tanning sails, fishing nets, etc.

Minerals.—Among minerals examined and reported on are copper ore, manganese ore, coal, limestone and "soapstone." The results of the examination of the last two materials were found to be of value in connection with an enquiry which was instituted into the possibility of manufacturing cement in Fiji, on which subject a detailed report was furnished to the authorities, dealing with methods of making cement, suitable raw materials available in Fiji, the plant and labour required for the purpose, etc.

Rhodesia

Oilseeds.—The cultivation of oilseeds promises to become an industry of considerable importance in Rhodesia. Two factories have been established for the preparation of oil, the residual oil-cake finding a ready market for cattle-feeding, and the export of sunflower seed and ground nuts has commenced. The Institute has assisted in the initial stages of this industry by examining samples of sunflower seed, sesame seed, linseed, castor seed, ground nut oil, etc., and reporting on their quality and commercial value.

In connection with the marketing of sunflower seeds the Institute was consulted by the Director of Agriculture as to the possibility of saving freight by shipping the decorticated kernels instead of the entire seeds. A sample of decorticated kernels examined at the Imperial Institute was found to be in good condition, and the oil present in them had not undergone any deterioration during transit. Information was supplied as to the best methods of packing the kernels for shipment. Enquiries made by the Institute at the request of the British South Africa Company as to the possibility of the whole of the Rhodesian crop finding a market in the United Kingdom indicated that there would be no difficulty in disposing of an increased quantity of Rhodesian sunflower seed in this country. The exports of this seed from Rhodesia to the United Kingdom have risen from 121,673 lb. in 1919 to 780,274 lb. in 1922. The Institute has also investigated the possible uses of sunflower stalks. Ash obtained in Rhodesia by burning the stalks has been examined, and the results have shown that it contains a large percentage of potassium carbonate, which could be separated by suitable means. The preparation of potassium carbonate from sunflower stalks in Rhodesia could, no doubt, be carried out on a commercial scale, as is done in Russia. Reports were also furnished on the suitability of the pith of the stalks for the manufacture of explosives and as a packing material in the sheathing of ships, and on the value of the stalks for the manufacture of paper pulp.

Fibres.—The Institute has examined and reported on a

considerable number of Rhodesian fibres, with reference to their possible commercial and industrial utilisation, including Sisal hemp, sunn hemp, Mauritius hemp, bow-string hemp, jute, ramie, banana fibre, Brachystegia fibre, pineapple fibre, flax, kapok, silk and cotton. The cottons examined include varieties of Egyptian, American Upland, and Nyasaland Upland cotton, which were grown experimentally in order to ascertain the suitability of the country for this crop. Some of the samples received were generally of good quality, and such cotton would be readily saleable in this country. Suggestions were made for obviating certain defects which the cottons exhibited. Silk cocoons were examined, which were of excellent reeling quality, whilst certain of the cordage fibres investigated were also on the whole of promising character. In connection with proposals for the manufacture of grain bags and hessian in Northern Rhodesia to meet the large local demand for these materials, the Imperial Institute examined the following fibres collected by the Director of Agriculture: *Hibiscus cannabinus*, *Urena lobata*, *Sida cordifolia*, *Hibiscus vitifolius*, *Triumfetta pentandra* and *Abutilon angulatum*. All these fibres were found to be suitable for use as jute substitutes for the manufacture of yarns, fabrics and twine, and information was supplied regarding the machinery required for the industry.

The Institute has also investigated certain native woods and barks in order to ascertain their suitability for the manufacture of paper pulp. None of the materials so far supplied, however, has proved of much value for this purpose.

Foodstuffs.—Coffee grown in the Government Experimental Gardens examined at the Institute was of good quality and suitable for the European market. Particulars were supplied regarding the preparation of commercial consignments for shipment to this country. Other foodstuffs examined and reported on include chicory, chillies, buckwheat, millet, *Canavalia obtusifolia* beans and diseased oranges.

Minerals.—Amongst the large number of minerals from Rhodesia investigated at the Institute may be mentioned chrome ore, iron ore, copper ore, molybdenum

ore, tantalum ore, platinum, antimony, barytes, magnesite, asbestos, graphite, mica, zircon, corundum, talc, auriferous quartz and potash-bearing shale. Rhodesia is now the largest producer of chrome ore in the world, the industry having commenced only in 1905. The Institute has examined specimens of the ore from time to time, the first sample in 1906, when the composition and commercial value of the ore was reported on to the British South Africa Company. Recently chromite "fines" were examined and found to be probably suitable for the manufacture of refractory bricks.

Other Products.—Rubber obtained from a number of indigenous trees and vines has been examined and reported on, including species of Landolphia, Ficus, Euphorbia and Diplorhynchus. Timbers investigated include Rhodesian teak, Rhodesian mahogany and mukwa. A number of samples of tobacco of promising quality have been examined, as well as samples of Stramonium leaves, Strophanthus seeds, papain, native tanning pods, kino and Brachystegia bark for tanning purposes, indigo, gum arabic, and the resin of *Copaifera Mopane.*

SUDAN

Foodstuffs.—The most important native foodstuff grown in the Sudan is dura, a variety of millet (*Sorghum vulgare*). Investigations have been carried out by the Institute and feeding trials arranged in this country, in order to determine the value of the grain as a feeding-stuff for animals. The results were exceedingly satisfactory. It was found that the dura closely resembles maize in chemical composition, and that it is about equal in value to the latter grain as a feeding-stuff for cattle and poultry. Experiments were also conducted in order to obtain definite information as to whether dura could be successfully used in the brewing industry. The dura was tried for malting, as roasted grain for colouring and flavouring purposes, for flaking, and for the production of glucose, with very promising results. The results of the investigation indicated that there would probably be a very large demand for the grain if it could be exported in large regular quantities. A certain quantity is already exported, but

the amount varies from year to year, owing to the fluctuating demand in the Sudan for the grain as native food, only the surplus remaining after the local demand has been met being at present available for export.

A sample of Liberian coffee, grown experimentally in the Sudan, proved on examination at the Institute to be of good quality. It was recommended, however, that before adopting this variety for extended cultivation experiments should be conducted with Arabian coffee. In response to this suggestion a sample of Arabian coffee, together with a further sample of Liberian coffee, was subsequently received for examination. The Arabian coffee was of good quality, far superior to the Liberian, and in view of this and the fact that there is a much greater demand in the United Kingdom for Arabian coffee, it was suggested that it would be preferable to devote attention in the Sudan to the cultivation of coffee of the latter type.

A small consignment of dates, representing three varieties, was received at the Institute for examination and sale. Although not equal to dessert dates of the best grade, they were of good quality, being similar to those from Persia, which find a regular market in this country. The consignment realised a satisfactory price, and it was considered by merchants that the prospects of establishing a trade in these Sudan dates were promising. Recommendations were made as to the best methods of packing and marketing the dates. Among other foodstuffs from the Sudan examined at the Institute were wheat, barley, maize, rice, beans, chillies, capsicums and ginger.

Tanning Materials.—The pods of *Acacia arabica*, known locally as sant pods, form one of the chief tanning materials of the Sudan. Examination of the whole pods at the Institute showed that they contain about 30 per cent. of tannin and that they yield leather of good quality and pale colour. They are, however, open to some objection on account of the seeds. A small consignment of the whole pods received at the Institute for sale realised a satisfactory price. It was shown that an even more valuable material can be prepared by crushing the pods and removing the seeds and fibrous matter by sifting.

This material, now known as "sant grains," contains from 50 to 60 per cent. of tannin. In view of the high value of the sant grains as a tanning agent, the Imperial Institute suggested that a consignment should be prepared and forwarded from the Sudan for further examination and sale. The technical trials conducted with this consignment gave satisfactory results, and the material was disposed of in London at £45 per ton. The tanners who purchased the consignment reported that the results were quite satisfactory, and further quantities have since been imported and sold. In addition to the work of the Institute in determining the tanning value of the sant grains and finding a market for them, assistance is being rendered to the Sudan authorities in connection with machinery for preparing the material from the pods, on which the future of the industry will largely depend.

Other native tanning materials from the Sudan examined include the barks of the following trees: *Parkia filicoidea*, *Prosopis oblonga*, *Ximenia americana* and a species of *Ficus*.

Fibres.—In connection with the establishment of the cotton-growing industry of the Sudan, a very large number of samples produced experimentally, and on estates, have been examined and reported on as to their quality and commercial value. These have included samples grown in all the different cotton-growing districts, including the important area in the Gezira, where a vast irrigation scheme is being developed.

Amongst other fibres examined at the Institute may be mentioned Dom palm fibre, the fibres of various species of *Sansevieria*, and of *Hibiscus cannabinus*, *Calotropis procera*, Dracæna, Leptadenia, Raphia and Pavonia, Mauritius hemp, pineapple fibre, jute and kapok. Mulberry and Eri silks have also been investigated.

Oilseeds, etc.—The character of the oil and the market value of a considerable number of Sudan oilseeds have been determined at the Institute. These include cultivated oilseeds, such as ground nuts, castor seed, sesame and linseed, and others from wild plants, including shea nuts, *Lophira alata*, *Balanites ægyptiaca*, senat seed, hameid seed, *Salvadora persica*, water-melon seed and

lettuce seed. Samples of native-produced beeswax have also been examined and reported on.

Gums.—Considerable attention has been devoted at the Institute to gum arabic, the production of which is one of the chief industries of the Sudan. The different kinds of gums produced have been investigated and their relative commercial values determined, whilst an extensive series of gums representing material, both as exported from the Sudan and also after being graded in Europe, has been examined. As a result of this work, recommendations were made with a view to improving the quality of the gum exported, so that it would realise higher prices. Other questions relating to the gum industry are at present under investigation.

Other Products.—Several samples of Ceara rubber, produced in the Sudan, have been examined, as well as rubber from the indigenous Landolphias. Of a series of ten different timbers examined with a view to determining their suitability for the English market, several proved to be distinctly useful woods, and one, *Soymida roupailfolia*, would answer the same purpose as cedar or mahogany and would be worth exporting. Talh wood, the product of a species of Acacia, was shown to be suitable for distillation for the production of acetone, acetic acid, methyl alcohol and charcoal. A number of drugs have been examined, including senna, Egyptian henbane, Stramonium and colocynth. Of essential oil plants investigated, mention may be made of *Cymbopogon senaarensis* and Ocimum. Other products dealt with include tobacco, dom palm nuts for use as vegetable ivory, indigo, mother-of-pearl shells, sponges, ostrich feathers, iron ore, natron, marble, petroleum and clay.

In addition to the native Sudan products, a number of materials imported into the country from Abyssinia have been forwarded by the Sudan authorities for examination, including samples of rubber, coffee and fibres.

Mesopotamia

With a view to improving the quality of the cotton grown in Mesopotamia, experiments have been conducted by the Agricultural Department with a number of varieties,

including American Upland, Egyptian and selected Indian kinds. Many samples of cotton grown in these experiments in different years have been examined at the Institute, and their quality and commercial value ascertained. The latest received were of good quality and superior to the earlier samples ; their length and strength, however, lacked uniformity, and suggestions were made for overcoming this defect.

Flax straw, produced experimentally at Bagdad, has been examined at the Institute. It proved to be well grown on the whole, and if suitably retted would probably furnish a useful flax of medium quality.

The Imperial Institute Committee on Silk Production has given much attention to the question of silk production in Mesopotamia. Cocoons raised by the Agricultural Department have been examined in the laboratories of the Institute, and also by the Committee. They proved to be of excellent quality, and reeling trials carried out on the Continent were quite satisfactory. A report on the subject is being prepared.

At the request of the Director of Agriculture in Mesopotamia, a memorandum was furnished dealing with the production and marketing of liquorice root and the preparation and uses of liquorice extract. At the suggestion of the Institute, samples representing two grades of liquorice root produced in Mesopotamia for export were forwarded for examination and valuation. They proved to represent material which would be readily saleable in this country, and it was suggested that a trial consignment should be sent to London for sale through the Institute.

An investigation has also been made of the composition of the ordinary Mesopotamian dates.

In view of the constant menace to crops in Mesopotamia owing to outbreaks of locusts, the assistance of the Imperial Institute was requested in connection with the provision of petroleum flares for the destruction of locusts in the hopper stage. Particulars were supplied as to the different types of such flares, and the merits of this method of control were discussed in relation to other methods in use. It was suggested that contact insecticides would probably be more effective than flame throwers. Experiments con-

ducted by the Agricultural Department in Mesopotamia in 1922 with insecticides recommended by the Institute gave fairly satisfactory results, but, owing to the special conditions obtaining in the country, further trials are necessary to decide the best means of control.

Information has also been furnished on the method of fumigating plants and seeds for the prevention of pests and diseases; on the grading of wheat and barley in connection with the transport of these products in Mesopotamia; and on the characters of Mesopotamian sheep-skins.

Palestine

Eri silk cocoons from Palestine examined at the Institute were of excellent quality, and an important firm in England offered to purchase a trial consignment of from one to two thousand pounds of the cocoons. The price offered for the cocoons, however, although higher than the current price of Indian Eri silk cocoons, was considered insufficient to be remunerative to the producer.

The assistance of the Institute was requested by the Government Analyst with regard to the cause of corrosion in the boiler tubes of railway engines. From the analyses furnished of different waters employed and from inspection of a section of a corroded tube, it appeared that the high proportion of magnesium chloride present in the waters was the principal cause of the corrosion. A full report on the whole subject was furnished by the Institute, in which various means for preventing corrosion were discussed, and it was pointed out that the softening of the waters before admission to the boiler, preferably by the lime-soda process, would probably be the most satisfactory. The authorities were put in touch with makers of suitable plant in the United Kingdom for softening water by this process.

At the request of the Government Analyst information was supplied as to possible substitutes for oak root bark, the material at present employed by tanners in Palestine for the tanning of goat-skins used for carrying water. Arising out of this enquiry, samples of the barks from the roots and branches of the oak in question (*Quercus coccifera*)

have been received at the Imperial Institute for comparative examination, together with a goat-skin as prepared in Palestine for tanning.

The Institute was also consulted by the Government Analyst with respect to certain regulations which it was proposed to introduce into Palestine concerning the importation of synthetic dyes. Information was particularly desired regarding methods of testing the fastness of dyes. The matter was discussed verbally at the Institute with the Government Analyst, and a memorandum was furnished giving detailed information respecting tests made by various investigators, with the object of establishing a suitable method for determining the comparative fastness of dyes.

Information has been supplied relating to Eucalyptus cultivation and to afforestation in desert lands, full reference to literature on these subjects being furnished. Enquiries regarding the mineral resources of the country have also been dealt with.

NUMERICAL SUMMARIES OF TECHNICAL INVESTIGATIONS AND ENQUIRIES, 1920–22

(1) Overseas Countries and Firms in the United Kingdom

	1920.	1921.	1922.	Total.
India	174	136	121	431
Dominions	238	216	262	716
Colonies and Protectorates, etc	528	464	474	1,466
Firms, etc, in United Kingdom	483	382	419	1,284
Other countries	116	62	58	236
Total	1,539	1,260	1,334	4,133

(2) Dominions and India

	1920.	1921.	1922.	Total
Canada	34	30	35	99
Australia	58	62	89	209
New Zealand	19	29	36	84
South Africa	119	90	89	298
Newfoundland	8	5	13	26
India	174	136	121	431

(3) COLONIES, PROTECTORATES, ETC.

	1920.	1921.	1922.	Total.
Ceylon	32	39	37	108
Mauritius	1	3	6	10
Seychelles	3	9	11	23
St. Helena	6	0	2	8
Federated Malay States	24	26	28	78
Straits Settlements	8	9	7	24
Hong Kong	5	2	1	8
North Borneo	15	18	7	40
Sarawak	0	0	1	1
Uganda	28	25	14	67
Kenya	92	70	52	214
Zanzibar and Pemba	2	3	6	11
Nyasaland	25	15	15	55
Tanganyika	5	6	20	31
Somaliland	4	2	1	7
Nigeria	60	45	45	150
Gold Coast	32	36	36	104
Sierra Leone	14	10	10	34
Gambia	4	9	17	30
Cyprus	10	16	21	47
Malta	2	1	1	4
West Indies	41	29	37	107
British Guiana	6	7	16	29
British Honduras	9	13	10	32
Falkland Islands	8	3	5	16
Fiji	9	3	3	15
Western Pacific	2	2	4	8
Rhodesia	34	25	24	83
Egypt	14	12	11	37
Sudan	23	21	16	60
Mesopotamia	6	3	3	12
Palestine	4	2	5	11
Wei-hai-wei	—	—	1	1
Ascension	—	—	1	1

ASSISTANCE RENDERED BY THE IMPERIAL INSTITUTE IN THE ESTABLISHMENT OF INDUSTRIES OVERSEAS

THE work of the Imperial Institute on the development of the natural resources of the Empire has been conducted in close co-operation with the Technical Departments (Agricultural, Forestry and Mining) in the Dominions, the Colonies and India. At the request of these Departments a number of extended investigations have been made of the principal raw materials occurring in the respective coun-

tries, and also of materials grown experimentally with the object of improving the native product or of introducing new products for cultivation. These investigations have covered nearly every variety of raw material, and the results have been of value to the Departments concerned by indicating the materials likely to repay commercial exploitation.

In the course of this work the Imperial Institute has rendered material assistance in laying the foundations for a number of important industries overseas. In many cases this pioneer work has extended over a number of years and has involved not only the examination and valuation of large numbers of samples of particular products grown experimentally, but also the supply of information and advice regarding methods of cultivation and preparation, the means of remedying defects in quality, the requirements of users in this country and other related questions concerned with the marketing of the material.

The following are examples of such investigations :

(1) The improvement of Gold Coast cocoa with a view to rendering it suitable for use by British manufacturers.

(2) The establishment of the tobacco-growing industry in Nyasaland.

(3) The improvement of the rubber produced in the tropical Colonies and latterly the investigations with a view to the improvement of plantation rubber in Ceylon.

(4) The development of cotton growing in Nyasaland, Uganda and other countries.

(5) The discovery, through the Mineral Surveys arranged by the Imperial Institute, of important deposits of coal and tinstone in Nigeria, and of thorium minerals in Ceylon, all of which materials were fully investigated and reported on by the Institute and are now being worked commercially.

The commercial development of a large number of other materials has also been due to investigations and commercial enquiries conducted by the Imperial Institute, and the following examples may be quoted :

(*a*) The utilisation of the Sant pods of the Sudan for tanning purposes in the United Kingdom.

(*b*) The manufacture of thymol in the United Kingdom and in India.

(*c*) The value of Indian opium for manufacturing purposes and its utilisation in the United Kingdom.

(*d*) The manufacture of atropine in the United Kingdom and the use of Egyptian henbane for the purpose.

(*e*) The production of wattle bark and extract in Natal and their utilisation by British tanners.

(*f*) The suitability of various products for paper-making and their utilisation in the countries of origin.

(*g*) The extension of silk production in India and Cyprus and the improvement of the product.

(*h*) The suitability of Canadian timbers for use in the United Kingdom and their inclusion in the Government Specification for Public Works and Buildings.

(*i*) The reintroduction of South African boxwood as a substitute for the Turkish and Persian wood.

(*j*) The medicinal value of the oil of *Croton Elliottianus* and its use in the United Kingdom.

(*k*) The production of origanum oil in Cyprus and its sale in the United Kingdom.

Short statements relating to each of the investigations mentioned above are appended.

Cocoa in the Gold Coast

The production of cocoa in the Gold Coast has shown remarkable development during recent years, and the exports from the Colony are now larger than those from any other country. The cocoa produced in the early days of the industry was, however, of inferior quality and was chiefly sold on the Continent and not in the United Kingdom. The industry was also hampered to some extent by certain trading difficulties.

Both these sides of the problem have received attention at the Imperial Institute in consultation with the Department of Agriculture. The question of the possible improvement of the cocoa was fully investigated and, as the result of the examination of a number of samples prepared in different ways, recommendations were made for the improvement of the methods of preparation employed. Subsequently two consignments of selected cocoa, prepared

by the processes suggested, were forwarded to the Imperial Institute for sale. Samples of these cocoas were widely distributed to British manufacturers and merchants, and the consignments were sold in this country at prices considerably in advance of those obtained for the ordinary grades of Gold Coast cocoas. This action demonstrated the fact that cocoa of the quality demanded by British manufacturers could be produced in the Gold Coast, and several firms in this country were induced to take an interest in the matter. One of the firms which had been in communication with the Imperial Institute (Messrs. Cadbury) despatched a representative to the Gold Coast to study the question on the spot, and subsequently established buying agencies in the Colony. Large quantities of Gold Coast cocoa are now regularly utilised in the United Kingdom.

Tobacco in Nyasaland

In view of the very large market for tobacco in the United Kingdom, considerable attention has been devoted by the Departments of Agriculture in a number of the Colonies to the production of tobaccos which will be suitable for export to this country. The Imperial Institute has rendered important assistance in these experiments by furnishing information and advice as to the varieties of tobacco in demand here, and the methods of cultivation and preparation to be adopted; by determining the suitability of soils for the cultivation of tobacco; and by examining and submitting to British manufacturers the tobaccos produced.

A long series of experiments on these lines was carried out in conjunction with the Department of Agriculture in Nyasaland, the results of which showed that the tobacco grown there would, if suitably treated, be readily saleable in this country. The question of the marketing of Nyasaland tobacco was then dealt with by the Institute. A large amount of special information was collected on this subject and a Conference was held at the Imperial Institute at which a number of matters were discussed relating to the use of Nyasaland tobacco in the United Kingdom and elsewhere, the best methods of marketing the product,

dock and warehouse charges, the grading and packing of the leaf in the Protectorate, and the improvement of the quality. A memorandum summarising the information collected by the Imperial Institute and the results of this Conference was forwarded to the Government of Nyasaland.

Important commercial developments took place as a result of this detailed investigation of Nyasaland tobacco, and the cultivation of the crop was largely extended in the Protectorate. Subsequently the Imperial Tobacco Co. established a buying agency in Nyasaland, and as the result of action taken by the Imperial Institute special smoking mixtures and cigarettes made from Nyasaland tobacco were placed on the market by British firms.

At the suggestion of the Imperial Institute the War Office in 1914 altered the specification for the tobacco supplied to the Army so as to permit the use of tobacco of satisfactory quality grown from American seed in British Colonies and Protectorates, thus enabling Nyasaland tobacco to be used in the supply of tobacco to the Army.

Rubber

The Imperial Institute has devoted continuous attention for many years to the subject of rubber. Before the establishment of the rubber planting industry in the East, the production of rubber from wild plants was of considerable importance in many British Colonies and Protectorates, and the Imperial Institute co-operated with the Agricultural and Forestry Departments in these countries in investigating the many problems involved. Systematic examination was made of practically all the "wild" rubbers produced in the various Colonies in order to determine their composition and value, and thus to ascertain which were worth commercial exploitation. The native methods of collecting and preparing these rubbers were also specially studied, and improved processes were suggested in certain cases whereby the value of the product was considerably enhanced. A large amount of work was done by the Institute in these pioneer experiments, a summary of which will be found in the *Selected Reports on Rubber*.

The supervision and control of the collection by

natives of rubber from wild plants occurring over wide areas was found to present many difficulties, and it was practically impossible to prevent the destruction of the plants. It became evident therefore that the best method of ensuring an adequate supply of rubber of good quality was the establishment of plantations of rubber trees on the lines adopted with the Para rubber tree in Malaya and Ceylon. Experiments on the cultivation of rubber trees were accordingly carried out in a considerable number of the Colonies, not only with the Para tree but also with Funtumia, Ceara, Castilloa, Sapium, Ficus and other rubber-yielding trees. The Imperial Institute assisted in this work by examining the rubber obtained and by furnishing information and advice on many technical questions relating to the tapping of the trees, the coagulation of the latex, and the form in which the rubber should be prepared.

In the course of this work numerous samples of rubber were reported on for the following countries:

India, Ceylon, Federated Malay States, Straits Settlements, Sarawak, Seychelles, Uganda, Kenya, Zanzibar, Nyasaland, Rhodesia, Natal, Transvaal, Nigeria (Northern and Southern), Gold Coast, Sierra Leone, Gambia, Sudan, Trinidad and Tobago, Dominica, British Guiana, St. Lucia, Jamaica.

In several of these countries, besides Ceylon and Malaya, commercial plantations of rubber trees were established.

The rapid growth of the plantation industry gave rise to many new problems, and in 1913 a Rubber Research Scheme was arranged by the Government of Ceylon in co-operation with the Institute, which provided for a careful and systematic investigation of plantation rubber, with a view to the production of better and more uniform rubber. Recently the scope of the Scheme has been extended by the amalgamation with it of the scheme of rubber research formerly carried out independently in Ceylon by the Rubber Growers' Association.

Over 500 specially prepared samples of rubber have been examined at the Imperial Institute in connection with the Scheme and further investigations are now in progress

both in Ceylon and at the Imperial Institute. The results already obtained have been of great value to the plantation industry.

Cotton

Work on cotton has been continuously carried on at the Imperial Institute for the last twenty years. It has consisted in the investigation of the quality of an enormous number of cottons grown in all parts of the world and the supply of information on all aspects of the cotton-growing industry. In some cases, the work has led to important results in connection with the establishment in British countries of new types of cotton or the improvement of existing types.

For example, specimens have been received from year to year of cotton of selected strains grown in a particular country with a view to the establishment of an improved type. The examination of such samples is of considerable interest and value as enabling a comparison to be made of the quality of the cotton obtained year by year in continued experiments and thus determining the degree of improvement or otherwise. As an example of this work mention may be made of the development and improvement of the "Nyasaland Upland" type which was carried out by the Department of Agriculture in Nyasaland. Samples of the produce of the various selections were regularly submitted to the Imperial Institute and the results of their investigation served each year as a guide to the selection work of the following year. In this way an excellent type was ultimately evolved and acclimatised, and for several years this cotton formed the bulk of the exports from the Protectorate and was recognised as a distinct commercial variety.

Assistance in the establishment of improved cottons has also been rendered in the case of Uganda and several other countries.

Coal and Lignite in Nigeria

The most important result of the Mineral Survey of Southern Nigeria, which was arranged by the Imperial Institute, was the discovery of the Udi coalfield estimated

to be at least 1,800 square miles in extent. An extensive series of samples of the coal was collected for examination at the Imperial Institute and the results showed that the coal was of good quality and suitable for general use, including steam-raising. The extent of the field was then determined approximately by the Officers of the Survey, who also selected the site at which development should be commenced. The field is now being worked by the Government of Nigeria and a large quantity of coal is produced annually (over 200,000 tons in 1921). There seems little doubt that this coal-field will ultimately be of the highest value in providing a fuel supply for West Africa. An account of the work done by the Mineral Survey in connection with this new West African coal-field is given in the article on "The New Coal-field in West Africa" in the Bulletin of the Imperial Institute, No. 3 of 1916. More recently further investigations of this coal in connection with briquetting and distillation have been made and are still in progress.

In addition to this discovery of coal, the Survey had previously investigated a large deposit of lignite or brown coal in Southern Nigeria, and this also was fully explored and described. The lignite was examined at the Imperial Institute and found to be of good quality and convertible by briquetting into a satisfactory fuel. The Institute investigated various methods of briquetting, and decided on the system best adapted to the purpose, and obtained a full specification of the plant required and the cost. Large-scale briquetting trials were also arranged and a consignment of lignite briquettes sent to Nigeria for firing trials. The investigation was therefore carried by the Imperial Institute up to the stage at which commercial development could begin, but the discovery of the Udi coal-field deferred further action as to the utilisation of the lignite.

Tin in Nigeria

The occurrence of tinstone in Northern Nigeria had been known for many years, but no systematic examination of the country to determine the extent of the deposits had been made until that undertaken by the Mineral Survey

arranged by the Imperial Institute. As a result of this Survey tinstone was found to be widely distributed in the Protectorate, being recorded from many localities in the Bauchi, Zaria, Muri, Nassarawa, Ilorin and Yola Provinces.

These discoveries regarding the distribution of tinstone in Northern Nigeria, together with the results of the examination at the Imperial Institute of a large number of concentrates obtained in the course of the work, were published in the reports of the Survey and attracted considerable attention in mining circles. The development of many of the tin areas examined and reported on by the Survey was soon taken up by mining engineers, and it may be claimed that the development of the tin mining industry of Northern Nigeria, which has now attained large dimensions, was principally due to the pioneer work of the Survey and the investigations conducted at the Imperial Institute. A large amount of British capital is now invested in this industry, and the ore is shipped to this country. The average exports in the three years 1919–21 amounted to 8,000 tons annually.

Thorium Minerals from Ceylon

Until comparatively recently the sole source of supply of thoria, the principal and essential constituent in the mantles used for incandescent gas lighting, was monazite from Brazil. The Brazilian deposits were under the control of the German Thorium Syndicate, which was thus able to monopolise the industry.

The discovery of the new mineral thorianite in Ceylon, which proved to be the richest source of thorium, was made by the Mineral Survey, carried on in co-operation with the Imperial Institute. This mineral furnished a small, independent supply of thoria, and its discovery gave a great stimulus to the search for thorium minerals.

Investigations of the Survey, suggested by the Imperial Institute, resulted in the discovery of beach deposits of monazite sand in Ceylon, some of which proved to be sufficiently extensive to justify their commercial exploitation. A large number of samples of the sand were examined by the Imperial Institute, which also conducted trials of concentrating machinery, and finally selected plant

which has been erected by the Government of Ceylon for working the sands. Commercial supplies of monazite from Ceylon are now available, and the Institute has assisted in disposing of consignments in the United Kingdom.

Sant Pods from the Sudan

Sant pods, derived from *Acacia arabica*, are utilised in the Sudan for tanning purposes, and as large supplies are available it was desired to create an export trade in them.

The examination of the pods at the Imperial Institute showed that they contain a high percentage of tannin, but it was found that their utilisation by tanners is hindered by the fact that the liquors made from them undergo undesirable fermentation during the tanning process, owing to the mucilage present in the seeds. The tannin is contained almost exclusively in the pod cases and by grinding the pods to a granular powder and then removing the seeds and fibrous matter by sifting, a superior product, containing up to 60 per cent. of tannin, is obtained which is free from the above objection. This material (" sant grains ") therefore appeared likely to be a valuable tanning agent, and at the request of the Imperial Institute a consignment was prepared in the Sudan for further examination and sale.

The technical trials gave very satisfactory results, and the material was disposed of at the price of £45 per ton ex store London. Further consignments, amounting in all to about 24 tons, have since been sold in London and there is no doubt that a regular market can be established for sant grains in this country. It is stated that 2,000 tons of the material could be produced annually in the Sudan, but that in order to develop the industry it will be necessary to procure a machine capable of preparing the grains from the pods. This question is now receiving the attention of the Imperial Institute in consultation with manufacturers, and it is anticipated that a suitable machine will be obtained.

Thymol

Thymol, which is extensively employed as an antiseptic, was formerly made almost exclusively in Germany

from Indian ajowan seeds, and the outbreak of the war resulted in stoppage of the supplies and a very considerable increase in price.

There was, however, no reason why the manufacture of thymol should not be carried on in the United Kingdom, and as the result of action taken by the Imperial Institute a number of British firms were interested in the subject. These firms were assisted to procure supplies of ajowan seed with a view to starting the manufacture of thymol, and were also given particulars of a method worked out at the Institute for producing the large transparent crystals of thymol as supplied by the German manufacturers. Information on the preparation of thymol was also forwarded to several enquirers in India, who were put in touch with British firms able to supply the necessary plant.

As a result of this action the manufacture of thymol has been established both in India and in the United Kingdom. Considerable quantities of thymol have since been imported into this country from India, and the Institute has assisted in the disposal of consignments.

Indian Opium

A detailed investigation of a large number of samples of Indian opium from different districts was conducted at the Imperial Institute some years ago, and the results conclusively proved that this opium contains on the average a much larger percentage of morphine and codeine than was usually supposed. The general opinion that Indian opium is unsuitable for medicinal use or for the manufacture of alkaloids was therefore shown to be unfounded.

The opium formerly used in this country was principally obtained from Turkey and Persia, and the outbreak of the war seriously interfered with supplies. The Imperial Institute had previously proposed that Indian opium should be utilised in this country for manufacturing purposes, and in view of the shortage of supplies the Government of India gave permission for the export of opium to the United Kingdom. Indian opium has since been freely employed by British makers of morphine and codeine, and during the four years 1916–19 the average

annual value of the imports into the United Kingdom was about £400,000.

Egyptian Henbane

Egyptian henbane was first investigated at the Imperial Institute in 1899 and shown to be one of the best sources of the alkaloid atropine which is largely used in medicine. At that time, however, the production of atropine was principally carried on in Germany, and British firms were not disposed to start its manufacture in competition with the German makers.

The stoppage of the German supplies of atropine on the outbreak of the war and the large demands for this drug for use in the army caused an extreme shortage in this country, and the attention of British manufacturing chemists was again drawn by the Imperial Institute to the possibilities of utilising the Egyptian henbane as a source of atropine. As a result of this action the manufacture of atropine was taken up by several firms in the United Kingdom, and during the years 1918–20 these firms purchased an average of 140 tons of Egyptian henbane annually for their requirements.

Wattle Bark and Extract

The important tanning material wattle bark was at first obtained wholly from natural forests in Australia, but was subsequently cultivated on a large scale in Natal, which is now the chief source of supply. During the early stages of the experiments in Natal the Imperial Institute rendered material assistance to the planters by examining barks grown under various conditions in order to determine their tanning value, and one result of this work was to show that wattle bark of good quality could be produced over a wide range of country. A large export trade in wattle bark had already been established in Natal before the war, but practically the whole of the supply went to Germany.

The outbreak of war caused a largely increased demand for leather in this country, and at the same time the supplies of tanning materials diminished owing to the cessation of imports from the Continent. These circumstances afforded a favourable opportunity for calling the

attention of tanners in the United Kingdom to the possibilities of wattle bark, and the Imperial Institute accordingly issued a circular giving information regarding the production of wattle bark in Natal and its value as a tanning material. This action evoked an immediate response, and a large number of firms in the United Kingdom were given information which enabled them to obtain supplies of the bark.

Wattle bark is now becoming increasingly popular with tanners in this country, and Germany has again taken considerable quantities recently. In view of the increasing demand for the bark it seemed desirable to investigate the possibilities of growing wattle in other parts of the Empire in order to increase supplies, and enquiries are now being made by the Imperial Institute in India, Ceylon, West Africa, Seychelles and the West Indies. The development of wattle-growing in certain countries will depend largely on cheap freights to Europe, and this aspect of the question is under consideration.

Assistance was also rendered by the Imperial Institute in starting the manufacture of wattle extract in Natal. Prior to the outbreak of the war steps had been taken for the erection of an extract factory, but these broke down, partly for financial reasons and partly because the plant had been ordered in Germany. The Imperial Institute, having ascertained that all the plant required could be obtained from British firms, urged that the project should be carried out, and as a result an order for the plant was placed with one of the firms recommended and the factory was established. The production of wattle bark extract has since become an important industry in Natal and large quantities are exported annually.

Paper-making Materials

Considerable attention has been devoted at the Imperial Institute during recent years to the investigation of possible paper-making materials, and the results have shown that there are numerous natural products in all parts of the Empire which are quite suitable for the purpose. In general, owing to the bulky nature of the raw materials and the high cost of transport entailed, it would not be

remunerative to export them to this country for manufacture, and it would therefore be necessary for them to be converted into pulp on the spot. The pulp could either be exported or employed to meet the demand for paper in the country of origin. In these circumstances immediate development is not always possible, but the following examples may be given of cases in which commercial action is under consideration.

The value of the bamboo which grows abundantly in Kenya Colony has been definitely proved by the investigations carried out at the Imperial Institute and the trials on a commercial scale which have been conducted on behalf of the Institute by a firm of paper manufacturers. The local Government has now published the conditions under which licences will be issued to work two large areas for the utilisation of the bamboo for paper-making.

In the case of the elephant grass of Uganda, the Institute has proved that this material is capable of yielding excellent paper and has carefully considered the costs involved in its manufacture into pulp in Uganda. The results show, however, that it is improbable that this enterprise could be commercially successful at present owing to the high cost of transport from Uganda.

Considerable attention has been given to the possibility of using the spent wattle bark of South Africa, which remains after the preparation of a tanning extract and has hitherto been a waste product, and the conditions have been ascertained under which the material can be converted into a satisfactory paper pulp. The erection of a mill in South Africa is now contemplated for the manufacture of paper and cardboard, for which there is a great demand in the Union, at present met by imported material.

The value of papyrus as a paper-making material has also been fully demonstrated. The commercial utilisation of this product in Zululand has been under consideration for some time, and a mill was established in 1920 for the production of pulp for export.

Large quantities of waste wood are produced annually in New Zealand and, at the suggestion of the Imperial Institute, specimens of the different woods were forwarded for investigation. As the result of technical trials it was

found that several of these woods are well suited for the manufacture of paper. The possibility of utilising the woods on a commercial scale in New Zealand is now receiving the attention of the Forest Service.

An investigation of waste cotton stalks which are left in the field after the cotton crop has been gathered has proved that they are a satisfactory source of paper pulp, and it has been suggested that manufacturing trials should be carried out in paper mills in India.

Silk

The action taken by the Imperial Institute, in conjunction with the Advisory Committee on Silk Production, to develop the production of silk within the Empire, has already given promising results in several cases.

Indian Silk.—A report has been furnished to the Government of India drawing attention to the importance of increasing the output and improving the quality of Indian silk, and suggesting measures which would achieve these results. The Government has stated that they recognise the importance of the question and that they propose to adopt a forward policy as soon as preliminary investigations have indicated the best course of action.

Recommendations were made for the improvement of Kashmir silk with a view to rendering it more suitable for use in this country. The most important recommendation had reference to the sizes in which the silk should be reeled, and as a direct result of the adoption of the suggestions made there is already a marked improvement in the sales of Kashmir raw silk in the United Kingdom. Arrangements were also made for the experimental cultivation in Kashmir of certain European races of silkworms yielding silks much valued by manufacturers. Parcels of eggs were despatched to Kashmir and the trials have given very satisfactory results. A consignment of the silk obtained is now under investigation in this country.

Trials have also been carried out with Mysore silk, which is at present regarded as unsuitable for this market. An examination of preliminary samples sent by the Mysore Government showed that the silk is of good quality, but

that better reeling is essential. Arrangements were therefore made to carry out reeling trials with Mysore cocoons in modern filatures, and also throwing and weaving experiments in the factories of members of the Silk Committee. The results demonstrate that, with modern methods of reeling, Mysore silk is of excellent quality and highly suitable for textile purposes in this country.

Cyprus Silk.—Cyprus is one of the most promising fields in the Empire for the development of sericulture, but the present position of the industry is not satisfactory. No modern filatures exist in the island, and the greater part of the cocoons are reeled in France and Italy, where the silk is bulked with material from other sources and its identity as Cyprus silk disappears. The silk, moreover, is lost to the British silk manufacturing industry.

The Silk Committee has fully considered the steps which might be taken to place the industry on a basis which would ensure greater profit to the growers and render the silk available for the British market, and has recommended that, under certain necessary conditions, a syndicate should be formed to organise and finance a modern filature in Cyprus capable of dealing with the normal production of cocoons. Estimates of the cost of establishing and working a filature on the lines proposed have been prepared and an offer with regard to the filature has been secured from an important firm with experience of similar work elsewhere. Enquiries are now being made with a view to considering the feasibility of the scheme from a local point of view.

Canadian Timbers

Increasing difficulty is experienced in this country in obtaining abundant supplies of softwoods, at satisfactory prices, for general construction purposes, and the possibility of procuring additional quantities from Empire sources has been considered by the Timbers Committee.

The Committee were of opinion that the principal constructional timbers of British Columbia, viz. Douglas fir, Sitka spruce and western hemlock, are well adapted for use in the United Kingdom, and likely to obtain an established position in this market if brought prominently

to the notice of architects, merchants and others. In this connection an enquiry had been received from the Agent-General for British Columbia for information as to British Government specifications for building timbers, and the Imperial Institute undertook to consult H.M. Office of Works as to the inclusion of selected British Columbia woods in the official building specifications of the Department. Arrangements were made for H.M. Office of Works to conduct practical trials and tests on consignments of Douglas fir, western hemlock, and spruce, on the understanding that the timbers would be included in the official specifications if the results proved satisfactory. The tests and practical trials, which extended over a period of many months, were carried out with timber supplied by the British Columbia Government to the Imperial Institute. The results proved entirely satisfactory and the three woods are now included in the building specifications of H.M. Office of Works.

A corresponding enquiry with reference to Eastern Canadian woods resulted in a number of valuable softwoods and hardwoods being recommended by the Committee as suitable for extended use in this country. Spruce and red pine should find a good market here since they form admirable substitutes for Baltic white and red deal respectively. Yellow or white pine is already well known, but should be more extensively used. H.M. Office of Works will permit the use of these Eastern Canadian timbers by contractors for Government buildings if the woods conform to the official standards of quality. It is also understood that the three softwoods mentioned have been accepted by the War Office as alternatives to European softwoods.

South African Boxwood

The Institute has been successful in reintroducing South African boxwood to the United Kingdom market. For some years English manufacturers had used almost exclusively boxwood from Turkey and Persia, but during the war supplies of these boxwoods could not be obtained. Manufacturers were therefore supplied by the Imperial Institute with samples of the South African wood and

requested to make trials with it. The wood proved to be satisfactory, and arrangements were made at the request of users for shipments to be forwarded from South Africa. Some difficulty was experienced in connection with certain consignments owing to the tendency of the wood to "check," *i.e.* to develop cracks after working, and recommendations were made by the Institute as to the storage and transportation of the wood with a view to obviating this defect so far as possible. This question, and also the further question of the best method of seasoning the wood, were subsequently considered by the Timbers Committee of the Imperial Institute, who furnished a report and undertook to arrange practical trials with special seasoning processes.

The suitability of South African boxwood for several industrial purposes was given wide publicity by means of an article in the Bulletin of the Imperial Institute, and the subject was also brought in other ways to the notice of those concerned. There is now a regular export of boxwood from South Africa.

Croton Seed from Kenya

An investigation at the Imperial Institute of the seeds of *Croton Elliottianus* from Kenya showed that these contain an oil which might be employed for soap-making, but in view of the known medicinal properties of the oil of the allied species *Croton Tiglium*, it was considered desirable to ascertain whether the oil of *C. Elliottianus* had any therapeutic action. Arrangements were accordingly made for pharmacological trials to be carried out at Aberdeen University, with the result that the oil was found to be a non-irritant cathartic similar to castor oil. It therefore appeared that the oil would be of value in medicine, and the Imperial Institute took steps to interest manufacturing druggists in the seed. One firm undertook to prepare the oil and to introduce it to medical men, and three consignments of the seed have been procured from Kenya for this purpose.

It seems probable that a regular demand will be created for the oil in this country.

Origanum Oil from Cyprus

The Institute has been closely associated with the development of the export trade in origanum oil from Cyprus. A detailed examination of the oil was carried out at the Imperial Institute in 1905 in order to determine its composition, and it was shown to contain a high proportion of carvacrol, which is a valuable antiseptic. Sales of consignments of the oil distilled at the Government Factory in the early years of the industry were made on the basis of analyses of samples at the Imperial Institute, and in this connection the Institute drew the attention of likely users to the constant composition and powerful antiseptic properties of the oil. As a result of this action a wider market and a higher price was obtained for the oil in the United Kingdom.

In connection with the disposal of consignments, it was ascertained that the value of the oil was frequently diminished by its dark colour, and the Institute accordingly worked out and supplied to the Government of Cyprus a method of preparing an oil which will remain practically colourless for long periods. Advice was also given as to the type of still required in Cyprus, together with the names of makers of suitable plant.

The production of origanum oil was taken over by a commercial firm in 1912, and regular shipments are made annually.

WORK OF THE IMPERIAL INSTITUTE WITH SPECIAL REFERENCE TO MINERAL RESOURCES

THE Imperial Institute is equipped with laboratories and assay rooms for mineral investigations, involving mineralogical or chemical analysis and assay. There is a special staff engaged in the work, with qualifications in geology, mineralogy and analysis, as well as assistants trained in the indexing and collection of commercial, statistical and technical information regarding minerals and metals.

The work relating to minerals is carried out in con-

nection with the Advisory Committee on Mineral Resources (see p. 97).

The following is a brief summary of the principal work conducted at the Institute with reference to the mineral resources of the Empire. It will be seen that the Imperial Institute has been closely associated with the establishment of several important mining industries in the Colonies, *e.g.* the production of Udi coal in Nigeria, the development of tin-mining in Nigeria, and the production of thorium minerals in Ceylon. The discovery of coal in Nigeria and of thorium minerals in Ceylon was made during the course of the Mineral Surveys of these countries arranged by the Imperial Institute, whilst the extensive distribution of tinstone in the Northern Provinces of Nigeria was first established by a similar Mineral Survey.

Some of the other important results of these Mineral Surveys conducted by the Imperial Institute were the discovery and investigation (1) of extensive deposits of lignite in Nigeria; (2) of large supplies of iron ore of good quality in Nigeria; and (3) of deposits of coal and cement-making materials in Nyasaland.

Other important mineral work carried out at the Imperial Institute has included the detailed examination of cement-making materials from a number of countries overseas, *e.g.* Newfoundland, Kenya, Nyasaland, Nigeria, India, Ceylon, Malaya and Fiji. The results have shown that suitable materials for the manufacture of cement of good quality occur in several of these countries, and the possibility of starting the industry is receiving local consideration in certain cases.

The examination and technical trials at the Imperial Institute of limestones and clays from Katni, Central Provinces, India, gave very promising results, and, after further technical trials on a large scale in the United Kingdom, the Katni Cement and Industrial Company was formed in India in 1912.

The Imperial Institute also carried out a detailed investigation of the soda deposit at Lake Magadi, in East Africa, prior to its commercial development. In response to an enquiry from the Colonial Office regarding

the composition and extent of this deposit, the Imperial Institute suggested that the occurrence should be investigated by an economic geologist and that the materials collected should be examined at the Imperial Institute. This suggestion was adopted, and as a result accurate information was obtained as to the quantity of soda occurring in the lake crust and the possibility of the latter being replenished from the streams flowing into the lake.

In many cases the investigation at the Imperial Institute of known minerals from new sources has shown that the products were of commercial value, and the producers have been put into communication with buyers in the United Kingdom. The following are examples of minerals of which consignments are known to have been ordered by firms as the result of action taken by the Imperial Institute : diatomite, tantalite, rutile and lithium minerals from Australia ; corundum from Transvaal ; mica from Central India, Ceylon and South Africa ; manganese ores and steatite from India ; beryl, monazite, thorianite and thorite from Ceylon ; and molybdenite and euxenite from Canada.

In addition to this work the Imperial Institute records important discoveries respecting minerals (especially within the British Empire) in the Bulletin of the Imperial Institute, and also in the Monographs on Mineral Resources. A Map and Diagrams illustrating the metal resources of the Empire in relation to those of the world has also been issued. These are referred to in the section on Publications (p. 111), whilst a selection of Press Notices and Reviews of Mineral Publications is given in the Appendix (p. 283).

The work of the Institute on minerals falls into three branches : Investigations, including analyses and assays ; Intelligence ; and Exhibitions.

Investigations

The investigations on minerals conducted at the Imperial Institute usually arise under four heads :

(*a*) Minerals for which a market is required or concerning which special information is needed are forwarded to the Institute for report by the Mines Departments or other

Government Departments in the Dominions, Colonies and India.

(*b*) The Institute directs attention overseas to minerals of which it appears that supplies are required in this country or in other parts of the Empire. This leads to the submission of samples for examination and valuation at the Institute.

(*c*) Minerals are received for investigation from special Surveys in overseas countries, certain of which have been carried on in association with the Imperial Institute.

(*d*) Minerals are forwarded for investigation and report by firms or individuals in various parts of the Empire.

The minerals received are first examined by the technical staff in the laboratories of the Institute as to composition and quality, so that an estimate of value may be subsequently obtained in consultation with manufacturers, merchants, etc. Full reports are forwarded to the Governments and correspondents concerned, with a request for any further information needed, such as extent of the deposits, names of producers, etc. Finally, when information is complete, any necessary action is taken by the Imperial Institute to establish a market for the mineral by putting producers in communication with British buyers, who are supplied with full information respecting the mineral in question. In certain cases the Imperial Institute takes charge of and supervises the sale on Government behalf of trial consignments. Examples of cases in which the Imperial Institute has arranged a market for minerals are quoted on p. 209.

In the course of each year the Institute receives minerals for examination from nearly every country in the Empire. Thus in 1920–22 minerals were examined and reported on from the following countries: Aden, Australia, British Guiana, Canada, Ceylon, Cyprus, Egypt, Falkland Islands, Fiji, Gambia, Gold Coast, India, Kenya, Malta, Mauritius, Mesopotamia, Newfoundland, New Zealand, Nigeria, Nyasaland, Rhodesia, St. Helena, Seychelles, Sierra Leone, Somaliland, South Africa, Straits Settlements, Uganda, West Indies and Zanzibar.

Mineral Surveys.—There are a number of countries, especially among the Crown Colonies and Protectorates, of which the mineral resources are little known. In some of these countries in which there was reason to believe that minerals of economic importance occurred, the Imperial Institute arranged with the Governments concerned for the necessary explorations to be made by competent geologists, with mining experience, specially selected for the purpose. These Mineral Surveys, arranged for terms of years, were directed from the economic standpoint and have been productive of important results.

The procedure followed in the case of these Surveys is that all minerals found by the Surveyors are forwarded to the Imperial Institute for examination, assay and commercial valuation, and any further explorations of the deposits which prove to be necessary are then arranged to be undertaken by the Surveyors. These Surveys were instituted by the Imperial Institute for the express purpose of ascertaining the existence and value of mineral deposits of probable commercial importance. It is not claimed that they serve the same scientific purpose as a Geological Survey, by which, in certain cases, they might be followed. They have proved to be most effective for their economic purpose, and it is clear that they might be extended with great advantage to several countries of which the mineral resources are at present not well known. A summary of the chief results obtained by the Mineral Surveys in various countries is given on pp. 219–224.

Intelligence

Published information respecting new occurrences of minerals of economic importance and new developments in their industrial utilisation is collected and arranged on a systematic plan, and the same course is adopted with regard to information periodically received from Departments of Mines and other Government Departments at home and overseas, and also from correspondents throughout the Empire. The Institute receives regularly the publications of Dominion, Colonial and Indian Government Departments concerned with minerals and metals, and these and similar publications issued by Foreign

Governments and by the various scientific and technical societies are dealt with, and also the technical and trade journals on these subjects. The whole of the indexed information is used in answering enquiries received at the Institute and in preparing publications and reports on mineral investigations, and important information is published periodically in the Bulletin.

The information on mineral resources thus systematically collected and indexed at the Imperial Institute has also been used for other important purposes, and especially during the war in answering enquiries made by the Admiralty, Ministry of Munitions and other Departments directly concerned with the war.

The Institute prepared for the War Trade Advisory Committee a map showing the principal petroleum resources of the Empire, and also compiled for the War Trade Intelligence Department a statistical and technical statement on the production and utilisation of certain metals and minerals in Germany before the war. The Institute was also largely consulted by the Treasury, War Trade Department, War Trade Intelligence Department, and by other Departments concerned with the questions involved in dealing with contraband trade in minerals and metals and the issue of licences for the export of such materials.

The Imperial Institute also prepared for the International Geological Congresses held at Stockholm and Toronto respectively, monographs on (1) "The Iron Ore Resources of the British Crown Colonies and Protectorates," and (2) "The Coal Resources of the British Crown Colonies and Protectorates," which were included in the General Reports on the Iron Ore and Coal Resources of the World issued by these Congresses.

Members of the staff of the Imperial Institute have contributed numerous papers to the British scientific and technical societies concerned with minerals, have served on the councils of these societies, and have taken part in the discussions which these societies have arranged in recent years on various aspects of mineral investigation.

Exhibitions

The Institute maintains Reference Sample Rooms, in

which are shown examples of all raw materials, including minerals, which have been investigated at the Institute and as to which full information is available regarding sources of supply, composition, uses and commercial value. These sample rooms have proved useful in dealing with verbal enquiries from merchants and manufacturers as to new sources of supply of raw materials within the Empire.

In addition to this special exhibition of fully investigated raw materials, the Imperial Institute maintains in its Public Exhibition Galleries a comprehensive exhibition of the chief raw materials, including minerals, of the Empire. This exhibition, which is in charge of a special staff, is arranged on a geographical system, all the countries of the Empire being represented. The minerals and mining industries of these countries are well illustrated; thus, in the Canadian section, there are exhibits of the chief minerals of the Dominion and other exhibits illustrating the uses to which they are applied in industries. For example, various grades of Canadian mica are shown, together with specimens of articles manufactured with mica. The same applies to asbestos, nickel, corundum and other minerals.

Minerals from countries overseas, for which a market is required, are brought to the notice of the Raw Materials Committee (see p. 81), and through it to the Chambers of Commerce throughout the country, and similarly these Chambers, through the Committee, bring to the notice of the Imperial Institute minerals for which there is a demand in the United Kingdom.

Illustrations of Results of the Work of the Imperial Institute on Minerals

Bauxites.—The Empire possesses in India and British Guiana large supplies of this important ore of aluminium, which still remain largely unutilised, chiefly because of their distance from places at which manufacture can be carried on. The Imperial Institute has fully examined in its laboratories bauxites from the most important deposits in Central India, and has shown that these are suitable for the manufacture of aluminium and aluminium

products. It has been in communication with those interested in the development of these deposits, and has given information with regard to the schemes which have at various times been put forward for their utilisation. These schemes have included the treatment of the bauxite for extraction of aluminium, manufacture of aluminium nitride with a view to the production of ammonia and alumina, use of the ground bauxite as a filtering medium, etc. The Institute has also called the attention of British manufacturers to the important bauxite deposits of British Guiana, which are now producing on a commercial scale.

Diatomite.—Before the war this country derived its supplies of diatomite largely from Germany, although this material occurred in the United Kingdom, and also in Kenya, Canada and Australia, to mention only a few of the British localities from which material has been examined and reported on by the Imperial Institute. Some years ago a considerable increase in the demand for diatomite arose through its use as a filtering medium. For this purpose diatomite of particularly good quality is required, and it is believed that this special quality was, before the war, being supplied by German agents from Australia. On the outbreak of war the Imperial Institute was consulted as to possible sources of supply of diatomite of high quality, and from investigations made it seemed clear that the diatomite of Lillicur, in Victoria, Australia, would answer the purpose. A trial quantity was obtained through the High Commissioner in London from the Mines Department of Victoria and distributed to possible users in this country. As a result several of these users requested supplies and were placed in communication with the producers, and consignments have been sold in London. Subsequently the producers were given the names of possible buyers in allied and neutral countries. This investigation also brought to light other sources of supply of diatomite in Australia and Canada, one of which is suitable for dynamite, for the manufacture of which a first consignment was purchased through the Imperial Institute by British manufacturers of explosives.

Corundum.—During the war a considerable amount of

interest was displayed by British firms in securing additional supplies of corundum, which is used as an abrasive. The Imperial Institute has been able to put producers of corundum in India in touch with manufacturers in this country, and it is hoped also to obtain supplies from the Federated Malay States. Before the war the corundum produced in the Northern Transvaal was beginning to be exported to Germany, and the war cut off this promising market. The Imperial Institute received samples of this Transvaal corundum, and as on examination it proved to be of fair quality, the producers were recommended to ship a trial consignment for sale in London. This was done and a good price was obtained. Transvaal corundum has since been regularly exported to this country.

Mica.—The Institute has investigated the quality and has reported on mica from Ceylon, Nigeria, Nyasaland, Kenya, India and elsewhere. Two illustrations may be given of effective commercial work in this connection. A deposit of mica of considerable extent has been located recently in Central India through the work of the Imperial Institute. A consignment of this mica was forwarded to the Institute for disposal in London. A report on the quality and grading of the mica was prepared in consultation with experts, and the graded mica was then sold at satisfactory prices. Samples of the grades were returned to the producers in India with instructions for the preparation, grading and packing of the mica for future guidance. The results of this action were satisfactory, and the Imperial Institute drew up a scheme to assist those concerned in the development of this deposit. Similar action was taken in connection with Ceylon mica.

Manganese Ores.—The Institute has reported on manganese ores from India, Union of South Africa, Kenya, Gold Coast and elsewhere, chiefly in connection with steel manufacture. Before the war the special manganese ore used for the manufacture of dry electrical batteries was obtained from Germany, and when this source of supply was cut off manufacturers were no longer able to produce satisfactory dry cells, which are used in large quantities for electric bells, telephones, etc. The difficulty was enhanced by the fact that no specification existed for

manganese ore for this purpose. The Imperial Institute made enquiries, the results of which made it possible to prepare a provisional specification. Then from the records the Institute possessed of the composition of manganese ores from all parts of the Empire it was possible to put manufacturers in touch with producers of the quality of ore required in Canada and India, and in a short time definite orders for supplies from these localities were given.

Ores for the Manufacture of "Special" Steels.—Prior to the war British steel-makers had relied largely on Germany, France and the United States for supplies of the alloys of titanium, tantalum, tungsten, molybdenum, etc., which are added to steel in the manufacture of the very hard and tough steels now used for making "high-speed" and other special steels which are of first-rate importance in modern engineering industries. Nearly all the ores from which these alloys are made are more or less monopolies of the British Empire, so far as production is concerned, though before the war the output went chiefly to foreign countries, where the alloys were made and exported to this country. This condition of things was remedied during the war, and the alloys are now being made here. The Institute had prepared and in some cases published complete records of the occurrence of these ores within the Empire, had made analyses of many of them and had in fact taken action with the Admiralty to get Western Australian tantalite used in this country for steel manufacture before the war. Early in 1915 there was a great shortage of molybdenite in this country, and the Institute took action to increase supplies. A memorandum was prepared stating the quality of ore required in this country, the possible sources of supply within the Empire, the value of the ore and the chief uses to which it was applied. Copies of this memorandum were sent to all the Mines Departments in those parts of the Empire where molybdenum ores were known to the Institute to be obtainable. A large increase in supplies to this country took place. This action was specially effective in Canada, and in a paper published in *National Progress* (Toronto) Mr. C. C. Mackenzie gives an account of the important developments of molybdenite production in that Dominion, directly

resulting from action taken by the Canadian Mines Department in response to the circular issued by the Imperial Institute.

The Imperial Institute has also been instrumental in placing alloy makers in this country in touch with producers of titanium ores in Australia and India, and of tungsten ores in India and South Africa. It has also provided the Admiralty with a detailed statement as to sources of supply of titanium ores within the Empire.

Monazite.—At one time the sole source of supply of thoria, the essential ingredient in the mantles used for incandescent gas lighting, was monazite from Brazil. The Brazilian deposits were under the control of the German Thorium Syndicate, which was thus in a position to fix the price. Many attempts were made to end this monopoly, and the Imperial Institute had given information to British firms who desired to secure independent sources of supply. The discovery of the new mineral thorianite in Ceylon, which proved to be the richest ore of thorium, was made by the Mineral Survey, carried on in co-operation with the Imperial Institute. It provided a new, though small, independent supply, and also gave a great stimulus to the search for thorium minerals. In recent years monazite has been found by the Imperial Institute in sands from Ceylon, Malay Peninsula, Nyasaland, Nigeria, and elsewhere in the Empire. The Imperial Institute also made the first analysis published of the monazite from Travancore, which is now the most important source of supply of this mineral in the world. Reference is made elsewhere (p. 222) to the subsequent discovery by the Mineral Survey of beach deposits of monazite sand in Ceylon, from which monazite is now being exported to this country.

Apart from the assistance thus given by the discovery of new sources of supply of monazite, the Imperial Institute has also contributed to the scientific and technical knowledge of thorianite, monazite and other thorium minerals, and a member of the Staff has contributed a number of papers dealing with monazite and other rare earth minerals to technical societies, and is also the author of a well-known work dealing with the rare earth industries.

Brick- and Tile-making Materials.—In view of the objections to corrugated iron as a roofing material in the tropics, the local production of roofing tiles is of great importance. Similarly, owing to the high cost of imported bricks and the comparatively short life of wooden buildings, the local manufacture of bricks demands careful attention. The Institute has been able to afford valuable assistance to a number of countries in both these directions. Clays have been received from Nigeria, Sierra Leone, Uganda, Kenya and Mauritius, and technical trials have been carried out at the Institute in order to ascertain their suitability for brick- and tile-making and to determine the best methods of manufacture for the particular material concerned. In all cases the reports which have been furnished to the particular country have been accompanied by specimen bricks and tiles made at the Imperial Institute under the conditions recommended for adoption.

Cement-making Materials.—The local manufacture of cement is of great importance in the tropics, as the price of European cement is high owing to the cost of shipment. Limestones, shales and clays from a number of countries have been examined at the Institute in order to determine their suitability for cement-making, notably from India, Kenya, Nyasaland, Fiji, Nigeria and Ceylon. Different kinds of cements, such as Portland cement, natural cement and hydraulic lime, have been made experimentally at the Institute. Full reports have been furnished on the results of the tests, and detailed information has been given as to the method of manufacture best adapted to the particular materials. In the case of India a detailed investigation was made of cement-making materials from the Central Provinces, and the manufacture of cement has since been undertaken on a large scale (see p. 208).

Coal.—Much attention has been devoted by the Institute to the question of the coal resources of the Empire, and samples from the following countries have been examined and their composition and fuel value determined: Australia, British Guiana, Federated Malay States, Grenada, India, Jamaica, Kenya, Newfoundland, Nigeria, Nyasaland, Somaliland, South Africa, Tanganyika and Trinidad. The results of the investigation of coals from

certain of these countries were included in the monograph on "The Coal Resources of the British Crown Colonies and Protectorates" referred to on p. 212. In the case of Nigeria the work of the Mineral Survey conducted by the Institute in the Southern Provinces resulted in the opening up of the Udi coal-field, which is of great importance to the development of West Africa (see p. 220). The lignite deposits discovered in the same country were also fully reported on.

Petroleum.—In 1903, at the request of the Admiralty, the Imperial Institute prepared a memorandum describing the known and prospective sources of supply of petroleum within the Empire. Since that time continuous attention has been given to this important subject, and a large number of samples of crude petroleum, oil shales, asphalt, etc., have been reported on from British Guiana, Trinidad, Barbados, New Brunswick, Newfoundland, Somaliland, Kenya, Gold Coast, Nigeria, Australia, Papua, etc. In certain of these cases important developments have since taken place, notably in Trinidad, whilst in others investigations are still in progress.

WORK IN CONNECTION WITH MINERAL SURVEYS

Nigeria.—The mineral resources of Nigeria being virtually unknown, the Director of the Imperial Institute suggested that as a first step to ascertain the facts a reconnaissance, to be termed a Mineral Survey, should be made. Mineral Surveys were sanctioned by the Secretary of State for the Colonies, commencing in the Southern Provinces in 1903 and ending in 1913, and in the Northern Provinces commencing in 1904 and ending in 1909.

Important minerals collected by the Surveyors were forwarded to the Imperial Institute for mineralogical and chemical investigation, and, if necessary, technical trials were made in communication with users as a first step towards commercial development. At the desire of the Colonial Office it was arranged that reports on the results of the Surveys, including these investigations, should be published for general information in the series of Colonial Reports, the officers of the Surveys being permitted to

publish suitable accounts of the geological observations made.

The Reports issued by the Imperial Institute, and subsequently published by the Colonial Office, have been in large demand and many are now out of print.

Northern Provinces.—In the Northern Provinces the tin-bearing granites were examined and tin was found to be present in alluvial deposits over a wide area. At that time only certain tin deposits in the Bauchi Province were known. Gradually a number of mining companies commenced operations and subsequently a railway was built, which has resulted in the Northern Provinces becoming one of the chief sources of tin. In 1908 the actual source of the tin in the Eri district was located by the surveyors in a pegmatite which, on crushing, yielded 20 per cent. of tinstone.

An important series of iron-ore deposits was found at Mount Patti, near the junction of the Niger and Benue Rivers. The ore is of great extent, and is covered by very slight overburden, so that it could readily be exploited. It would yield about 50 per cent. of the metal.

A considerable amount of work was done at the Imperial Institute in examining native salts produced in the Northern Provinces. The weak brine at Awe was investigated, and it was shown that by suitable treatment this might be made to yield salt which could be sold at a price much below that obtaining in the Colony. Large deposits of limestone, suitable for the production of lime, were located in Bassa Province and in North Kabba.

Southern Provinces.—In the Southern Provinces large deposits of high-grade fuels in the form of lignite and bituminous coal were discovered in several localities and investigated. The bituminous coal of the Udi district has now been opened up and a railway built to the district. It forms one of the country's most valuable assets, is being worked by the Government, and is a considerable source of revenue. The question of the utilisation of the lignite was considered at the Imperial Institute, and briquetting trials were carried out with success. There seems little doubt that when the need arises these lignite

deposits will be capable of producing a large quantity of satisfactory fuel.

The lead-zinc ores of the Abakaliki district were examined and found to be of considerable extent and of good quality so far as base metals are concerned, but the amount of silver was too low to make the deposits worth working. Tinstone concentrates were found at numerous localities, those around Akwa-Ibami averaging 3 lb. of ore per ton. Although inferior to the deposits in the Northern Provinces, these may pay to work when tin is scarce. Large deposits of limestones suitable for lime-burning were found, and clays suitable for pottery and brick-making are abundant in some localities.

During these surveys much valuable information of a general geological and geographical nature was obtained, which was summarised in the published reports and formed the subject of various papers and other publications by the officers of the Survey.

Nyasaland.—The Mineral Survey of Nyasaland (British Central Africa) was instituted in 1906 and carried on until 1909, the object being to obtain general information respecting the occurrence of minerals in the country and to collect and forward to the Imperial Institute specimens of minerals and rocks in order to ascertain the country's economic possibilities. The specimens were examined mineralogically and chemically, and where necessary (as, for instance, in the case of cement-making materials), preliminary technical trials were carried out in addition.

The chief result was the discovery and investigation of the coal-bearing district close to the shore of Lake Nyasa. The coal was found to vary considerably in different fields, that from the Mount Waller area being of the most promising quality and quite suitable for use as a fuel and for the production of gas and coke. Iron ores of fair quality were found in abundance, and flake graphite of good quality was met with. Limestones were examined in great number, and some were found to be suitable for making good hydraulic lime, whilst many were well adapted for burning for building lime, or, if mixed with suitable clay, for producing Portland cement. The results

of the Mineral Survey showed that valuable mineral resources exist in the country, which are at present undeveloped, chiefly owing to the absence of facilities for transport, except near the lake.

A large number of specimens, chiefly of coal and cement-making materials, recently sent by the Government Geologist, have been examined at the Imperial Institute. The majority of the coals were obtained from the occurrences previously examined by the Mineral Survey, and confirmed the conclusions previously reached at the Institute regarding the quality of the coal.

The chemical examination and technical trial of a large number of limestones and clays has demonstrated the presence of materials suitable for the manufacture of either Portland cement or the more cheaply produced "natural" cement.

Ceylon:—The Mineral Survey of Ceylon was commenced in 1903, at the suggestion of and in association with the Imperial Institute. At that time the only minerals produced were graphite, salt and gemstones, and these were chiefly worked by native methods.

The first result of the Survey was the discovery and commercial development of the thorium-bearing minerals urgently required for use in the gas-lighting industry. The new mineral, thorianite, was first identified as the result of investigation at the Imperial Institute, and although its occurrence was proved to be spasmodic, considerable quantities were exported and sold through the agency of the Institute. Subsequently, at the suggestion of the Imperial Institute, the beach sands of Ceylon were investigated, and these proved to contain the valuable mineral monazite, which can be used for the same purposes. Preliminary work on the method of concentrating these sands was carried out at the Institute, as a result of which the necessary plant was purchased and sent to Ceylon. This was installed in a factory at Bentota, and proved quite satisfactory. A new industry was thus inaugurated under Government auspices, and a considerable amount of monazite has been exported to this country and sold with the assistance of the Imperial Institute. There is also reason to believe that uses may be found for the by-

products of these deposits, since both ilmenite and zircon are attracting commercial attention at the present time. Negotiations are now in progress for the sale of the entire output of the ilmenite.

The work of searching for and developing the deposits of these valuable thorium-bearing minerals absorbed much of the time of the Surveyors, but other economic minerals were investigated. Phlogopite mica of good quality was found to be rather sparsely distributed, the most promising deposits being near Kandy. Towards the close of the war, owing to the demand for mica, the Principal Mineral Surveyor, in communication with the Imperial Institute, was put in charge of a scheme for placing Ceylon mica, properly graded and trimmed, on the London market. The scheme was successful and the demand has continued, but on account of the small size and irregular nature of the deposits and the consequent high cost of production, work ceased when the price of mica fell recently.

There are large deposits of iron ore in the island, but, since there is no coal, these could not be profitably worked there.

The mode of occurrence of graphite has been studied, and much useful information published, which has materially assisted the native industry.

A large number of concentrated river gravels were examined, and some of these will probably repay working, notably one from the Weralupe dola, Ratnapura, which contained tinstone, thorium minerals and gold. A few small deposits of clear quartz suitable for the production of fused glass ware, etc., were found, and also clays suitable for ordinary pottery. Most of the limestones were dolomitic, and therefore unsuitable for lime or cement-making, but the travertine limestone which has been met with is suitable for both these purposes.

Gwalior State, Central India.—The object of the Mineral Survey of Gwalior was to examine the mineral deposits already known to occur, in order to decide which (if any) were of sufficient importance to justify their exploitation on modern lines, and also to search promising areas in the hope of finding additional deposits. The preliminary field work lasted from 1912 to 1917, and a large amount of

material was sent to the Imperial Institute for examination during that time. Advice was given that in the Gangapur mica mines the present methods of mining should give place to systematic vein-mining methods. Deposits of limestone and clay suitable for Portland cement-making were found in the Sheopur district, notably at Kailaras. A few clays, suitable for making common pottery, were located. The State's chief mineral is building stone, of which there is a large amount available of excellent quality.

Anglo-Congolese Boundary.—During the progress of the Anglo-Congolese Boundary Commission a large number of mineral specimens were collected by the Geologist, who was attached to the Commission at the suggestion of the Imperial Institute, in order to get some idea of the mineral resources of the territory in question. A number of minerals were sent to the Imperial Institute for examination.

The majority of these specimens were more of scientific interest than of economic importance, but good-quality hæmatite was found at Kazinga, auriferous sands in the streams flowing from Mount Ruwenzori, and a low-grade lignite at Engiti River. The salt deposits and water of Lake Katwe were of interest on account of the local industry.

Falkland Islands.—A number of minerals collected by the Government Geologist in the Falkland Islands have recently been examined at the Imperial Institute. Some of these were duplicates of material previously examined at the Institute. The peat deposits of the island contain compact peat of good quality.

A number of samples of guano were analysed, but in most cases the material was of little or no commercial value.

Windward and Leeward Islands.—A large number of mineral specimens collected recently in connection with the geological examination of these islands have been investigated at the Imperial Institute.

It was shown that the deposits of phosphate rock which occur on Anguilla Island are of high grade, and that the lignite is worth further investigation.

ILLUSTRATIONS OF THE WORK OF THE IMPERIAL INSTITUTE IN CONNECTION WITH INDUSTRIAL PROBLEMS RAISED BY THE WAR

(*Prepared in* 1915)

The work of the Imperial Institute is chiefly carried on through two Departments, the Public Exhibition Galleries and the Scientific and Technical Research Department, of which the Technical Information Bureau is now a branch.

The Public Exhibition Galleries form a permanent exhibition of the raw materials and partially manufactured products obtainable from all parts of the Empire. The principal object is to bring home to the public, and especially to the British manufacturer, the fact that many of the raw materials required for industrial purposes in this country are produced within the Empire.

The Scientific and Technical Research Department supplements and completes the work of the Public Exhibition Galleries. The object of the Department is to investigate in its laboratories and workshops new or little-known raw materials from all parts of the Empire, and so to ascertain how and where these materials can be utilised. For this purpose the Department maintains a scientific and technical staff, and carries on its work in close touch with commercial and technical experts in this country and in communication with British manufacturers.

Apart from their special work these two Departments receive annually an increasing number of enquiries of a technical and commercial character, partly from Government Departments, and partly from business and manufacturing firms, as well as from visitors to the Institute. The number of these enquiries during the war became so considerable that the Secretary of State for the Colonies sanctioned the formation at the Imperial Institute of a special Branch—the Technical Information Bureau—for dealing with these.

The war caused great difficulties in the organisation of the work of the Institute. A considerable proportion of

the staff went on military service, the difference between their salaries and their army pay being paid to them by the Institute. The remaining staff was insufficient to cope with the rapidity desired with the numerous enquiries sent in by British manufacturers and Colonial and Indian producers confronted with new and unexpected problems brought about by the war, in the supply and disposal of raw and partly manufactured materials. In spite of the most strenuous exertions of the staff this congestion still continues.

The following tabular statement will serve to indicate the extent and variety of the special work accomplished. The statement covers only the period 1st October 1914 to 31st March 1915:

Enquiries dealt with . . .	907	
Letters received	1,384	Total correspondence, 7,554.
Letters, notices, etc., despatched .	6,170	

The enquiries so far dealt with may be divided into the following groups:

Sources of supply and methods of manufacture of chemical products	100
Oilseeds, oils, fats, and waxes	235
Essential oils and drugs	107
Food-grains and feeding stuffs	90
Gums and resins	27
Tobacco	6
Fibres	60
Tanning materials and natural dyes	55
Rubber	6
Timbers	11
Minerals	46
Bones, hides, skins and other animal products . . .	15
Miscellaneous enquiries	149
	907

The majority of these enquiries are the direct result of the outbreak of war, and the following illustrative examples of them may be given:

1. Assistance to British Manufacturers as regards Sources of Supply and Methods of Manufacture of Chemical Products

Of the enquiries included under this head a large proportion relate to five main groups: (*a*) potash, (*b*)

chemicals and raw materials employed in glass manufacture, (*c*) chemicals used in making mantles for incandescent gas lighting, (*d*) intermediate products for the manufacture of artificial dyes, and (*e*) drugs.

Potash

Owing to the possession of the Stassfurt deposits Germany enjoyed for many years a virtual monopoly in the supply of potash salts of all kinds. Potash is almost indispensable in many industries, and the immediately available sources of supply outside Germany are confined to wood ashes, kelp, wool-washings and beet-sugar factory residues. Attempts have been made in the United States, Italy and elsewhere to utilise potash-bearing rocks for this purpose, but up to the present time these have not been entirely successful.

The Technical Information Bureau has supplied enquirers with a list of the firms in the United Kingdom and in allied and neutral countries who were producing potash from the raw materials and the waste products referred to above. The Scientific and Technical Research Department of the Imperial Institute has conducted an extensive investigation as to the possible sources of supply outside the German deposits, and including potash-bearing rocks and the means of utilising them.

Glass Manufacture

Among other manufactures for which potash is required is that of glass. British glass manufacturers not only suffered from severe competition from Germany and Austria before the war, but when the war broke out they were handicapped by their dependence on foreign sources of supply for raw materials and chemicals. Many of the enquiries received at the end of 1914 were for assistance on this subject. Some of them were of special importance as concerning glass urgently required for optical instruments for naval and military use. Fortunately in every instance the Institute was able to find British manufacturers who could produce the chemicals required in a sufficiently pure state. A specially interesting case is that of a chemical material used in silvering reflectors for

searchlights. This product, which had never before been made in this country, is now being manufactured regularly in London.

Incandescent Gas Mantles

In spite of the fact that large quantities of mantles for incandescent gas lighting are made and used in this country, the whole industry has been virtually under German control, owing to the fact that the essential mineral ingredients of the mantles, such as thorium nitrate, etc., are exclusively made in Germany from the mineral monazite, the deposits of which are almost all, directly or indirectly, in German hands. On the outbreak of war the source of supply was cut off, but as the result of investigations carried out in the Scientific and Technical Research Department during the last few years the Imperial Institute was able to afford a certain amount of help to British makers of incandescent mantles by assisting them to secure special supplies of monazite, and by placing them in touch with British firms prepared to make thorium nitrate, beryllium nitrate and other chemicals.

Drugs and Chemicals

Information has also been supplied as to the methods of manufacture and the plant required for the preparation of a number of synthetic drugs, such as phenacetin, salicylic acid, etc., and for the production of intermediate materials for artificial dye manufacture.

Reference may also be made to the investigation for an important industrial association in the North of England of the methods available for utilising large quantities of sulphur dioxide produced in smelting operations hitherto carried on on the Continent and the establishment of which in the United Kingdom is now being considered.

2. Disposal of Colonial and Indian Raw Materials and the Establishment of New British Industries

It will be observed from the table given on page 226 that a large proportion of the enquiries dealt with relate to raw materials, as to which information has been systematically

collected at the Imperial Institute for many years. The outbreak of war caused serious difficulties in the disposal of Colonial and Indian raw materials, not only as a result of financial troubles, but also by the closure of the German and Austrian markets. Thus, of the copra or dried coconut exported annually from Ceylon and India, nearly four-fifths (1,363,000 cwts.) went to Germany. In British West Africa practically the whole export of palm kernels, valued at nearly £4,000,000 annually, was taken by Germany. These are only two out of a number of examples which might be quoted in which British Dependencies had come to rely upon Germany for a market for their produce. The outbreak of war seriously dislocated all this trade. The Imperial Institute has devoted a great deal of attention to finding markets for these products in this country, and, as the following paragraphs show, considerable success has already been achieved in this direction.

Oilseed Crushing Industry

Palm Kernels.—The total export of palm kernels from British West Africa in 1912, the last year for which complete figures are available, amounted to about 250,000 tons, valued at about £3,800,000. Of this 193,019 tons, valued at £2,845,268, are recorded as having been exported direct to Germany. Of the remainder, most of which went to the United Kingdom in the first instance, a good deal was probably re-exported to Germany. The total imports of palm kernels to Hamburg in 1912 from West Africa, but excluding German West African possessions, amounted to 257,937 tons, valued at £4,781,955.

The oil from the kernels was expressed mainly near Hamburg, and of the two products, palm-kernel oil and palm-kernel cake, the former was largely used in preparing edible fats, such as margarine, of which a good deal was exported. The cake was mostly used in Germany, but some was exported to Holland, Denmark and other neighbouring countries.

On the outbreak of war it became clear that there would be difficulty in finding a market for the palm kernels which had hitherto gone to Germany. An article

was prepared at the Imperial Institute giving details of the trade in palm kernels and an account of the properties and uses of the oil and cake. This was published in the Bulletin of the Imperial Institute, and the attention of British oilseed crushers was called to it by means of a special circular. A notice was also issued to the Press on the subject, and this was widely reproduced. As a result of this action by the Imperial Institute several firms expressed a desire to begin crushing oil-palm kernels, and they were placed in communication with West African merchants who could supply the kernels.

It was realised from the first that although it would be easy to dispose of all the palm-kernel oil made in this country it would be difficult to sell the cake, owing to the fact that British farmers do not take readily to new feeding-stuffs for their live stock. At this stage the subject was taken up by the West African Section of the London Chamber of Commerce. Agricultural Colleges and Experiment Stations all over the country received supplies of palm-kernel cake for feeding trials. At the same time the Section reprinted the article from the Bulletin of the Imperial Institute referred to above, together with other reports, in a pamphlet which was widely distributed among farmers and others. The Imperial Institute then published a second article, dealing in detail with the feeding value of palm-kernel cake, and giving the composition of the cake as now made by British manufacturers. The Institute also co-operated with the Board of Agriculture in preparing a special leaflet, which was issued by the Board to farmers throughout the United Kingdom.

As a result of this work, palm kernels are now selling freely in the United Kingdom at good prices, and it seems fairly certain that the palm-kernel crushing industry will be permanently established in this country, provided that satisfactory prices can be arranged between the West African traders and the British oilseed crushers, and that certain improvements in shipping facilities, notably between West Africa and Hull, are made.

Copra.—The question of finding new markets for the large quantities of copra hitherto exported from Ceylon to

Germany and Austria-Hungary has also been successfully dealt with. The problem was referred to the Imperial Institute by the Colonial Office in September 1914. The German Trade Returns showed that in addition to Ceylon, India, Malaya and other British Possessions were largely dependent on Germany as a market for their copra, the total imports of this product from British territories to Germany and Austria-Hungary in 1913 being about 154,000 tons, valued at about £3,250,000.

A circular giving statistical and technical information regarding copra was at once prepared at the Imperial Institute and distributed to British merchants and brokers, and Colonial and Indian Chambers of Commerce and Planters' Associations likely to be interested, and to the principal oilseed crushers in the United Kingdom. This circular was also sent to the Governments of all the British territories that produce copra in quantity, and they were asked to furnish the names of the principal local exporters. In this way it became possible to put buyers in the United Kingdom into touch with producers in the Colonies and India.

The Imperial Institute has been assured recently by British firms who have taken up the crushing of copra, or have extended their plant for this purpose, and also by Producers' Associations in Ceylon, that as a result of its action there is now no difficulty in disposing of all the copra that can be produced there.

As in the case of palm kernels, the chief difficulty in making copra-crushing on a large scale a permanent British industry will be that of finding a market for the cake left after the oil (coconut oil) is expressed. This can only be done by popularising the cake as a feeding material for live stock among British farmers. The Imperial Institute has co-operated with the Board of Agriculture in dealing with this question, and the Board's leaflet, referred to above under Palm Kernels, also deals with the feeding value of coconut cake.

It is possible to gain some idea of the extent to which this work at the Imperial Institute has been effective by reference to the monthly trade returns of the United Kingdom. In these returns palm kernels and copra are

included under the heading "Nuts and Kernels for expressing oil therefrom." The returns under this heading show that whereas in the nine months July 1913 to March 1914 the gross imports amounted to 68,363 tons, valued at £1,671,227, in the corresponding nine months of 1914 and 1915 they had risen to 239,091 tons, valued at £4,926,047. The net imports and values, *i.e.* the quantities and values of the products retained in the United Kingdom to be worked up, were as follows in the same periods :

	Quantity. *Tons.*	Value. £
1913–14 (July–March) . . .	47,553	1,150,510
1914–15 (July–March) . . .	177,092	3,482,890
Increase	129,539	2,332,380

Ground Nuts.—The case of these nuts is similar to that of palm kernels and copra, but it affects India as the chief producer and France as the principal consumer before the war. The nuts furnish an edible oil and a residue of value as a feeding-stuff for stock. The industry of crushing ground nuts is chiefly centred in Marseilles. France is, however, no longer in a position to take the large supplies which were obtained from India before the war, and a new market for the Indian nuts has to be found. Action on the lines described under Copra and Palm Kernels has been taken with British manufacturers, and the work is still in progress. Much has already been done to popularise the ground nut as an edible nut in the United Kingdom, and also as a raw material for vegetable oil manufacture. A special circular was prepared and circulated, as in the case of copra.

Tanning and Dyeing Industries

The outbreak of war caused an immediate scarcity of leather, owing to the large demands for Army equipment. At the same time it produced a scarcity of tanning materials, due to the cessation of imports of oak bark from Belgium, valonia from Turkey, tanning extracts from Austria-Hungary, Germany and Belgium, and a reduction in the supplies of these materials from France and certain neutral countries.

This seemed, therefore, a good opportunity of popu-

larising an excellent tanning material, wattle bark, in the United Kingdom. This bark is produced on a large scale in Natal and to a less extent in Australia, and it has hitherto almost all been exported to Germany. In January of the present year the Imperial Institute prepared and issued a circular giving information regarding the production of wattle bark and its value as a tanning material. The circular was issued in the first instance to producers in Natal and to brokers and merchants dealing in tanning materials in the United Kingdom, so that they might be prepared for any demand that might arise from British tanners. The circular was then distributed to tanners in the United Kingdom. It evoked an immediate response, and a large number of firms were given further information which would enable them to obtain supplies of the bark.

It became clear in the course of this work that British tanners would prefer to buy wattle bark extract in place of the bark itself. It also transpired that negotiations had been in progress in Natal prior to the outbreak of war for the erection of an extract factory, but that these had broken down, partly for financial reasons and partly because the plant for the factory had been ordered in Germany. The Imperial Institute then communicated with the authorities in South Africa, pointing out the desirability of this work being proceeded with, and showing that all the plant required could be obtained from British firms, whose names and addresses were given. A representative of those interested in wattle bark production in Natal was then in London, and he was given introductions to a number of British firms who were prepared to buy wattle bark extract. The Imperial Institute has now been informed that the difficulties have been successfully overcome, and that an order for the plant has been placed with one of the British firms of engineers which it had recommended.

One of the minor effects of the war has been a revival of interest in certain natural dye-stuffs such as indigo and fustic, the former being required for naval clothing, and the latter being one of the dyes which can be used for khaki cloth. It is understood that steps are being taken

to plant larger areas with indigo in India this season, so that the present scarcity of indigo will probably correct itself in due course. As regards fustic, the Imperial Institute called the attention of the Government of Jamaica to the use of this dyewood in preparing khaki cloth, and negotiations are now in progress for increasing the export thence to the United Kingdom. In normal times the bulk of the fustic from Jamaica goes to the United States, France and Germany.

Essential Oils and Drugs

Thymol.—One of the remarkable features of German trade is the success with which that country has almost completely monopolised a number of small but important and highly remunerative industries. A typical instance is the manufacture of glass for optical instruments, which led to difficulties in this country on the outbreak of war. Another case is the manufacture of thymol, a substance of great importance as an antiseptic. The raw material for thymol manufacture is ajowan seeds, which are only obtainable from India. Nearly the whole of the Indian exports of these seeds before the war went to Germany, where they were used for preparing thymol, so that Germany had a monopoly in the supply of this article. The effect of the cessation of German supplies of thymol on the outbreak of war is shown in the rise in price of thymol in London, which in July, 1914, was quoted at about 7*s.* 6*d.* a lb., and on March 31, 1915, was quoted at 25*s.* a lb.

The Institute called public attention to this subject by press notices, and as a result enquiries were received from a number of firms desirous of taking up thymol manufacture. These firms were supplied with names of Indian exporters of ajowan seeds, and with a detailed description of the method of extracting thymol from the seeds. At the same time attention has been called to the possibility of using carvacrol from Cyprus origanum oil as a substitute for thymol.

Atropine.—At a meeting of the Pharmaceutical Society held on December 8, 1914, a prominent manufacturing druggist in London stated that owing to the large Army

requirements, atropine sulphate was almost unobtainable and commanded high prices. The best source of this drug is Egyptian henbane, a plant which was investigated for the first time by the Imperial Institute in 1899, and attention drawn to its importance. At that time the Institute also directed the attention of British manufacturers to this plant and recommended its use as a source of atropine, and several British firms began importing it for this purpose. In recent years, however, owing to the special attention which German merchants seem to have devoted to securing a large share of the Egyptian export trade, the supplies of this henbane have fallen more and more into German hands, and even after the outbreak of war it was stated that it was still being exported to Germany through neutral countries, and there is at the moment a scarcity of the plant in Egypt itself. The attention of British manufacturing druggists has again been called to the material, and they have been placed in communication with dealers in Egypt who can supply it. The attention of the Egyptian Government has also been drawn to the importance of this plant, and the Government is now endeavouring to increase the supply by encouraging its cultivation on waste lands.

Senna.—Another Egyptian drug, the supplies of which were controlled by Germans before the war, is senna. A London firm has, however, now sent out a representative to Egypt, who will endeavour to establish direct relationships with Egyptian producers. This representative came to the Institute before proceeding to Egypt, and, on the basis of information received from him and from the National Health Committee and other sources, the Imperial Institute directed the attention of the authorities in Egypt and the Sudan to this subject. As a result, it is understood that the export of senna from Egypt is now prohibited, except to the United Kingdom and French ports.

Opium and Morphine.—Another drug which is of great and direct importance in connection with the war is the alkaloid morphine, which is prepared from opium. The production of opium on a large scale is confined to Turkey, Persia and India. The supplies from Turkey have now

ceased, and the export of opium from India has hitherto been prohibited, except in very small quantities for special purposes. The manufacture of morphine is one of the few chemical industries in which Great Britain is predominant, so much so that it actually exports large quantities of morphine to Germany. This British industry is for the moment chiefly dependent on Persia for supplies of its raw material, opium. It is satisfactory, in this connection, to note that the Government of India has now taken a course which has been urged upon it for years by the Imperial Institute, and is allowing Indian opium to be exported to this country for medicinal purposes.

Certain morphine manufacturers are now negotiating for supplies of this opium, and both they and the India Office are receiving assistance from the Imperial Institute in the technical difficulties which invariably attend the use of a raw material of this kind from a new source. These difficulties would disappear entirely if, as should be possible, the quality of Indian opium were improved, and the Imperial Institute has suggested to the Indian Government operations designed to achieve this object.

Minerals

Since the war broke out attention has from time to time been directed in the public press to the rapidity with which naval armaments of the highest quality can be produced in this country. This is in no small measure due to the introduction of what are known as "special steels," ranging from the nickel steel used for the tubes of naval guns to chromium, tungsten, molybdenum, tantalum, vanadium, and other "steels" employed in making the modern machine tools which have revolutionised the processes of naval construction. The British Empire is fortunate in possessing supplies of the ores of nickel, chromium, tungsten, molybdenum, tantalum, vanadium, etc., which are the sources of the metals used in producing these "special steels."

Unfortunately, the industry of reducing, or smelting, these ores has received but little attention in this country, and before the war British steel makers were content to purchase the metals, or alloys containing them, from

France and Germany. The Imperial Institute has long recognised the seriousness of this position, and has been in communication with steel makers on the subject. It has also compiled and published in its official bulletin articles dealing in detail with the occurrence, distribution, production, and uses of these ores throughout the world. These articles have been widely reprinted in the technical journals and have undoubtedly done much to draw attention to the importance of this subject. It is, therefore, satisfactory to be able to state that since the war broke out manufacturers have taken this problem seriously in hand, and that works for smelting these ores are erected in Lancashire and in Bedfordshire.

So far as is known only one case of scarcity of these ores has yet occurred since the war broke out. The ore in question is molybdenite, and a special circular on this subject has been distributed by the Imperial Institute to the authorities of those Colonies in which deposits of molybdenite are known to occur. As soon as the names of producers are known they will be communicated to buyers of the ores in this country.

A great deal of work has already bee done by the Institute in facilitating the disposal of bismuth, tungsten, zinc, lead and other ores produced in Australia and elsewhere in the Empire to British smelters since the war broke out. In many cases these Australian and other Colonial producers have hitherto relied on the German market.

The cases referred to above are only a few of the more important and typical instances in which the Imperial Institute has been able to render conspicuous service to Colonial and Indian producers and to British manufacturers in dealing with the serious problems of the disposal and supply of raw materials resulting from the dislocation of trade caused by the war. They are sufficient to show that the Institute has been able to assist in the transfer of a large volume of German trade to this country. In this connection it may be pointed out that this assistance could not have been given so rapidly and so efficiently unless the Institute had been able to draw on the large resources of technical and other information that it has

accumulated during the last 20 years, during which it has been constantly at work investigating the utilisation of the natural resources of the Empire. As a result of all this work the Institute possesses a unique collection of the raw materials obtainable from all parts of the Empire, and these are available to the British manufacturer in the Public Exhibition Galleries of the Institute.

The records of the Scientific and Technical Research Department of the Institute contain detailed technical information regarding the composition, value and possible industrial applications of all these resources, and this information is now being utilised by the Institute in dealing with the difficult and complex problems that are being placed before it every day from all parts of the Empire.

APPENDIX

Statement giving illustrations of specific instances in which the information supplied by the Imperial Institute, in connection with Industrial Problems caused by the Outbreak of War, has been of value to British Traders and Manufacturers.

THE tables given on page 226 indicate clearly that both producers of raw materials and manufacturers have availed themselves freely of the services of the Imperial Institute in obtaining information of value to them in connection with the disposal of raw materials on the one hand, and the industrial utilisation of raw products on the other.

The present statement furnishes evidence that these services of the Imperial Institute are valued by those to whom they have been rendered. In this connection a quotation may first be made from a letter recently received by the Director of the Imperial Institute from the Governor-General of the Sudan, a country whose economic development has been assisted in no small measure by the work of the Imperial Institute : "I congratulate you on having ready for use at a time when it is particularly needed an organisation which, as I know, is the result of years of hard work. It is a great tribute to your foresight, and I wish you every success."

It is not always easy to give specific instances of the actual transfer of foreign trade to British firms, or of the increase in trade of those firms resulting from the action of the Imperial Institute. The essence of success in work of this kind depends on inspiring firms with confidence that their transactions will not be made public by the

institution they consult. Moreover, action is frequently taken by firms on the basis of information supplied to them by the Institute, and the latter is not informed of the developments which have taken place.

It may be of interest, however, to quote a few out of numerous statements that have been made by firms and others who have consulted the Imperial Institute, indicating that they have taken action on the basis of the information supplied or in which such information has proved useful to them.

(1) Disposal of Colonial and Indian Raw Materials and the Establishment of New British Industries

(a) *Oilseed Crushing Industry*

The following statements have been made by firms, etc., who have been supplied with information regarding palm kernels, copra, ground nuts and other oilseeds :

Palm Kernels

"We are much obliged by your very exhaustive answer of the 6th instant to our enquiries [on palm kernels], and beg to inform you that we are regular purchasers of 'The Bulletin of the Imperial Institute.'

"We are sure that everybody will welcome the formation of the Technical Information Bureau at the Imperial Institute as a great aid to the development of trade and industries." (12th November, 1914.)

"We may say that we are going in for this trade [manufacture of palm-kernel oil], and have already dealt with small parcels for experimental purposes. There are, however, several difficulties with which we have to contend before definitely entering into contracts, the principal of which is the export of the [palm-kernel] meal produced." (20th October, 1914.)

"The issue by the Board of Agriculture of special leaflets, articles, etc., in regard to this cake [palm-kernel cake] has no doubt materially assisted in spreading a wider knowledge of its properties ; whilst valuable work in the same direction has been done by the Imperial Institute, the agricultural press, and, to a necessarily limited extent, the daily press." (Extract from Circular, dated 5th March, 1915, of the West African Section of the London Chamber of Commerce on Palm Kernels.)

Copra

"Owing to the fact that our crushing plant is not adapted for copra we are unable to interest ourselves in

this article at the moment. We are, however, considering the advisability of putting up additional plant for dealing with materials of this kind, and we are much obliged to you for sending us the report of your Technical Information Bureau, which will be of material assistance to us." (4th November, 1914.)

"I wish to thank you very much for your letter of the 30th instant and the very valuable information [on copra and coir] which you have given me. I much appreciate all the trouble you have taken on my behalf." (31st March, 1915.)

"We issued a circular to our shareholders drawing attention to the facts related in your circular of October 31st, but in less detail. In consequence of the response to our circular we have been able to install additional machinery in our mills for crushing copra, which machinery has already been at work for nearly a month. By means of it the output of our mills has been largely increased. Moreover, the erection of another, the fourth of our copra mills, is proceeding rapidly, and by the time it is completed we shall be in a position to handle a very large proportion of what was formerly Germany's trade." (4th November, 1914.)

"A little while ago we received a circular letter from you dated 31st October, in which you were good enough to volunteer information of firms, both in this country and the British possessions, who could supply copra in large quantities. In the hope that this may tend to increase our source of supplies, we should be very pleased to hear from you on the subject. We may mention that our mill is capable at the present time of crushing about 15,000 tons of copra per annum, and if circumstances warranted we might be prepared to further increase our plant." (24th November 1914.)

"Some little time ago I had the pleasure of receiving from you data relative to coconut oil and cake. I am now completing arrangements for putting down a plant for same, and I understand that you have information relative to the demand for the oil and cake in this country, which, if so, needless to say, I should be very glad to receive.

"Could you also give me any data relative to palm oil and cake?" (29th April, 1915.)

"We are extremely obliged for this information [on copra], and beg to thank you." (6th November, 1914.)

"We thank you for your circular of the 31st ultimo, and are very much obliged for the valuable information contained therein with regard to commerce in copra.

"The figures that have been collected are most valuable, and of great interest to us, as we are occupied to a very large extent in the article." (11th November, 1914.)

"I thank you for your favour of the 30th instant with the names of English makers of coconut cake, palm-kernel cake, and producers of copra, etc., which I believe will be most useful to me." (1st April, 1915.)

"We beg to thank you for your memorandum of the 31st ultimo, and for the important and interesting information you have been good enough to send us with regard to markets for Colonial and Indian copra." (5th November, 1914.)

"Thanks to prompt representations made by His Excellency the Governor at the inception of the war and the response by the Imperial Institute . . . we have been favoured with a good buying market in London for our copra throughout (freight being available, thanks to the British Navy). Both New York and London keenly compete to purchase all the oil we can turn out, and have since considerably increased the price, the latest quotations being equal to over £50 delivered in London, per ton, of good Ceylon oil." (Extract from letter sent by The Low Country Products Association of Ceylon to the Colonial Secretary at Colombo, 17th December, 1914.)

Ground Nuts

"We have to thank you for your favour of the 16th instant, together with the paper on ground nuts, which we found most interesting, and if circulated amongst the oilseed crushers in this country should go a long way to inducing them to use more ground nuts than hitherto." (22nd February, 1915.)

"We are very much obliged to you for the information you give us with regard to the production of ground nuts in the British Colonies.

"With regard to parcels for United Kingdom markets, we are keeping the information before us that you give us, and we certainly do feel that the crushers in the United Kingdom are missing a great opportunity in not crushing ground nuts here." (19th February, 1915.)

"We beg to thank you for your circular of the 16th instant, enclosing statement prepared by the Technical Information Bureau on the question of ground nuts. As importers of ground nuts, this statement will be of great interest." (19th February, 1915.)

"In further reply to your favour of the 16th instant, we are now able to state that the prospects for importing

ground nuts into the United Kingdom are good, and we shall be glad if you will kindly put us in direct communication with Indian and Nigerian exporters." (27th February, 1915.)

"We have your favour of the 16th instant to hand and are certainly much interested in all we read therein, and are obliged to you for bringing the ground nuts to our notice." (20th February, 1915.)

"I duly received your favour of the 1st instant, for which I beg to thank you. I duly note the names of shippers of Indian ground nuts and their London agents, with whom I am communicating, and trust that business may result." (4th March, 1915.)

"I must thank you for your letter of the 20th instant and at the same time express my best thanks for the kind assistance which you have given me in this matter [securing a licence to import machinery for a new oil works to work copra, palm kernels and ground nuts]. I have already received a notification from the Foreign Office." (23rd April, 1915.)

"We thank you for your kind favour of the 18th instant, giving us a list of exporters of Burma ground nuts, which we have read with much interest, and which we hope will result in our being able to do business with one or more of the firms mentioned." (19th March, 1915.)

"None of our mills is yet in a position to supply this [ground-nut cake] but we expect to be placing cake on the market by about April." (11th February, 1915.)

(b) *Tanning and Dyeing Industry*

"I thank you for circular, etc., *re* wattle bark. Owing to the war I have not been able to get my usual supply of valonia, and have just started using wattle bark." (8th January, 1915.)

"I thank you for your letter of the 14th instant *re* wattle bark; by the same post I received the 'Bulletin,' Vol. ix, No. 2, 1911, giving more particulars of the same.

"I have recently placed orders for 30 tons of the bark, and if I find it answer will continue its use. Again thanking you for all your information." (15th January, 1915.)

"We are in receipt of your valued favour of yesterday's date in reply to our letter of the 8th instant, regarding above [wattle bark], and we should be extremely indebted to you if you would put us in communication with the two gentlemen from Natal you referred to.

"We may say that since we wrote you last we have now secured a contract for a plant for Natal to make solid extract from wattle bark, and we have also a very

large order in hand for Natal for a plant for the distillation of the wattle wood and the recovery of the by-products from same." (30th January, 1915.)

"We thank you for your favour of the 4th instant, and for the trouble you have taken in the matter of wattle bark, which we highly appreciate." (5th February 1915.)

"We beg you to accept our sincere apologies that the great pressure of business is responsible for the delay in replying to your very kind favour of the 7th instant with reference to wattle bark. We should be extremely obliged if you will be good enough to favour us with the names of absolutely first-hand firms for this product. At the same time we respectfully beg to inquire if you have any objection to us reprinting your valuable article on the subject, and circularising it amongst our British tanners, or has this already been done?" (16th January, 1915.)

"We are in receipt of yours of the 7th instant, with regard to wattle bark, and are interested in the information you give.

"We shall be very pleased to have any further information you can give us from time to time, as we are able to use large quantities of this product." (11th January, 1915.)

(c) *Essential Oils and Drugs*

Thymol and Ajowan Seeds

"Please accept our best thanks for your letter of the 13th instant. We believe that the information [on the preparation of thymol] contained therein will be of considerable use to us." (14th November, 1914.)

"I beg to acknowledge the receipt of your letter of date 24th instant giving particulars of recent prices of ajowan seeds and thymol. This affords the information I was anxious to have and I have to tender my best thanks.

"I also acknowledge receipt of your further letter of same date giving the name of a firm of importers of the seeds, for which I am obliged." (29th December, 1914.)

"We beg to acknowledge the receipt of yours of yesterday's date, and are much obliged for the information you give us [exporters of ajowan seed]. We are communicating with the firms in question. We note the article which will be published in the forthcoming 'Bulletin of the Imperial Institute,' and are asking the publishers to send us a copy in due course." (21st January, 1915.)

"We beg to thank you for your favour of the 16th instant, giving us names and addresses of Bombay exporters of ajowan seeds.

"We are taking steps to communicate with them with a view to business." (18th January, 1915.)

"We are much obliged for your favour of the 20th instant, and are communicating with the firms named therein. If we can obtain a reasonable quantity of ajowan seeds we will give the matter some attention, with the view of considering whether it is possible for us to entertain the manufacture of thymol therefrom on our own account." (22nd January, 1915.)

"We are very much obliged for your letter of the 20th replying to our inquiry of the 15th, and we have carefully noted the information given to us.

"We greatly appreciate the explicit nature of your communication [on ajowan seeds], which will be very helpful to us in our undertaking." (22nd January, 1915.)

"We beg to thank you for yours of the 25th instant giving us the names of exporters of ajowan seeds, with whom we are communicating.

"We also thank you for drawing our attention to the fact that there will be an article on the scarcity of thymol in the forthcoming Bulletin of the Imperial Institute." (29th January, 1915.)

"We are much obliged for your letter addressed to the writer. We propose to take this matter [supply of ajowan seed] up with Messrs.————." (4th February, 1915.)

Hyoscyamus and Atropine

In order to avoid the quotation of extracts from a large number of letters on this subject, the following letter, dated 29th January, 1915, from the Imperial Institute to the Ministry of Agriculture at Cairo may be given, as showing the steps taken by the Imperial Institute to find a market for *Hyoscyamus muticus* from Egypt in the United Kingdom:

"With reference to your letter, Commercial No. 54, of the 23rd November and previous correspondence, I now enclose a report on the *Hyoscyamus muticus* from Egypt which was forwarded to the Imperial Institute with your letter, Commercial No. 8, of the 4th October last.

"The firms of manufacturing chemists who have been consulted as to the prospects of finding a market for the material in the United Kingdom expressed great interest in the material, and were referred for supplies to Mr. ————, in accordance with your letter of the 23rd November. It is hoped that this action will result in finding an extended market for the plant in the United Kingdom."

The results of the action described in the above letter are shown in the four following extracts :

" Hyoscyamus seems to have been plentifully obtained by ————, who says that he has large orders, which he is filling, and that he has actually exported to some extent." (*Ministry of Agriculture, Cairo,* 11th March, 1914.)

" I am unable to give you definite information as to the quantity of Hyoscyamus available, but when I have all the machinery of collection working, I consider that I should be able to deal with approximately 200 tons. I have already in hand orders for more than half that weight." (25th February, 1915.)

" We are in receipt of your letter of the 19th instant and we are much obliged to you for the information you have been good enough to give us. We have to-day written to Mr. ————." (25th March, 1915.)

" We have to acknowledge receipt of your favour of the 30th ultimo and are very much obliged for the information given [on preparation of atropine] therein. We believe that it will be of considerable value to us. We may mention for your information that we have already several tons of Hyoscyamus en route from Egypt." (21st March, 1915.)

" Reading your article on the Imperial Institute [a descriptive article published in the *Chemist and Druggist* of 24th April 1915], I could not but ask myself whether we pharmacists familiarise ourselves sufficiently with the larger aspects of British commerce ? How many of us have visited the Institute, or have any idea of what it has to show us even in our own comparatively narrow groove of business ? I do not know a more interesting, or, for a pharmacist, a more instructive exhibition in London. An hour spent there may teach us more of the raw materials of pharmacy than we sometimes learn in a year in our own shops." (Extract from an article in the *Chemist and Druggist,* dated 1st May, 1915.)

(d) *Minerals*

" We thank you for your letter of the 28th ultimo, enclosing an interesting statement on the sources and uses of molybdenum ores. It is information of this kind which is of service to makers, and we hope that you will continue your good work.

" A copy of this statement has been sent to our Chairman, who joins us in the above remarks." (4th May, 1915.)

" With reference to the introduction of Mr.

which you were good enough to arrange, we may say that we are at the present moment awaiting a further sample. Mr. ———— is now on his way to India and we hope that this sample will reach us shortly. Should this prove to be satisfactory we believe we shall be able to do a considerable amount of business with ————." (10th May, 1915.)

(2) Assistance to British Manufacturers as regards Sources of Supply and Methods of Manufacture of Chemical Products

————, in acknowledging a list of the names of firms able to supply potash salts, state that they are writing to the firms mentioned, and are in hopes that business will result. (3rd November, 1914.)

————, in acknowledging a letter giving information as to sources of supply of potash salts, say "we believe this will be extremely useful to us." (12th November, 1914.)

————, for whom seven enquiries have been dealt with since October 1914, make the following statements in certain of their letters:

"The information you have given us recently respecting carbonate of potash, barium and zinc oxide has been very useful, and will be even more so in the future." (27th November, 1914.)

"We have to thank you for your letter of the 5th instant, and for the interesting report enclosed on available methods for the preparation of pure potassium carbonate.

"We have taken the liberty to forward your report to Messrs. ————, who may possibly consider this question of the preparation of pure potassium carbonate." (10th December, 1914.)

"Allow us to thank you for the information you give in yours of yesterday as to makers of antimony oxide, and we are accordingly communicating with the two firms named." (16th December, 1914.)

————, one of the firms to whom Messrs. ———— were introduced by the Imperial Institute as willing to undertake the manufacture of pure glucose of a quality hitherto only made in Germany, stated:

"Since you were kind enough to put Messrs. ———— into communication with me respecting pure glucose, I am writing to state that the matter now appears to be on a satisfactory basis. Messrs. ———— are now purchasing their glucose from us regularly. It may also interest you to know that we are supplying a number of users, including the War Office, with a pure medicinal glucose; this also,

we believe, has always previously been obtained from Germany." (10th March, 1915.)

————, who has sent six enquiries to the Imperial Institute since September 1914, and who has taken a special interest in the attempts now being made to manufacture (1) chemicals for incandescent gas lighting, and (2) glass, has written as follows in two of his letters of acknowledgment:

"Again I am indebted to you for your painstaking goodness on my behalf. I shall certainly approach the firms [makers of potash products] and see what can be obtained." (24th September, 1914.)

"Let me express my sincere thanks for your interesting and valuable letter of yesterday's date on the subject of the manufacture of rings for gas mantles." (24th November, 1914.)

APPENDIX

RESOLUTION RESPECTING THE WORK OF THE IMPERIAL INSTITUTE, ADDRESSED TO THE PRIME MINISTER BY THE ASSOCIATION OF BRITISH CHAMBERS OF COMMERCE

The Council of the Association of British Chambers of Commerce, at a meeting held on 7th March, 1923, decided that the following letter and resolution should be addressed to the Prime Minister:

14 Queen Anne's Gate, Westminster, S.W. 1.,
12th March, 1923.

Sir,

I have the honour, by direction of the President and Council of this Association, to transmit to you the terms of a resolution with reference to the Imperial Institute which was unanimously endorsed at the Meeting of the Executive Council of this Association held on the 7th March.

This resolution was submitted to the Council by the Raw Materials Committee, which was formed largely on the initiative of the Association in 1916.

The Executive Council warmly support the views expressed in the Committee's resolution, and they desire me to transmit to you at the same time copies of the resolutions and views expressed by this Association and by Chambers of Commerce on previous occasions with respect to the value of the work of the Imperial Institute.

The Association trusts that His Majesty's Government

will maintain and extend the operations of the Imperial Institute.

I am to express the hope that these views and those of the Committee will receive your most careful consideration before any action is taken as a result of the Committee of Enquiry now sitting.

I have the honour to be, Sir,
Your obedient Servant,
R. B. DUNWOODY, *Secretary.*

The Right Hon. A. BONAR LAW, M.P.,
Prime Minister,
10, Downing Street, S.W.1.

Resolution

"Since its appointment in 1916 the Raw Materials Committee, nominated by the Association of British Chambers of Commerce, and including representatives of the principal Chambers of Commerce throughout the country, has assembled at least twice a year to consider and discuss the work which is conducted at the Imperial Institute on the utilisation of raw materials derived from all parts of the Empire.

"The Committee has been greatly impressed with the importance and value of this work to trade and industry, with the ability with which it has been carried on, and with the great possibilities of the extension of its scope and usefulness as the trade of the Empire becomes normal.

"The Committee, and through it the Chambers of Commerce, has been glad to assist by advising on many questions, and has been able to disseminate information of great interest and importance as to the results of this work.

"The Imperial Institute is the only organisation in this country that is exclusively devoted to such work. The Institute has the great advantage of long experience in dealing with the problems of utilising raw materials, and has a large store of accumulated knowledge which enables it to give invaluable assistance both in developing overseas sources of supply and to those concerned with the usage of raw materials in this country.

"The Committee desires to suggest to the Association of British Chambers of Commerce the expediency of representing to the Prime Minister the need for the maintenance and extension of the operations of the Imperial Institute, and at the same time of asking for an assurance that the views of the Chambers of Commerce will be heard before any decision affecting these operations is come to by the Committee of Enquiry now sitting."

(*Signed*)

A. F. FIRTH (*Chairman*), Ex-President, Association of British Chambers of Commerce.
FRED W. ASTBURY, Manchester Chamber of Commerce.
CECIL GRAHAM, Glasgow Chamber of Commerce.
G. A. MOORE, Liverpool Chamber of Commerce.
JAS. PICKERING-JONES, Liverpool Chamber of Commerce.
CECIL POWELL, Bristol Chamber of Commerce.
ALFRED RÉE, Manchester Chamber of Commerce.
STUART A. RUSSELL, London Chamber of Commerce.
WM. F. RUSSELL, Glasgow Chamber of Commerce.
ARTHUR MICHAEL SAMUEL, Norwich Chamber of Commerce.
HAROLD H. SISSONS, Hull Chamber of Commerce.

23rd February, 1923.

The resolutions and views referred to in the third paragraph of the Association's letter are as follows:

Association of British Chambers of Commerce, 1918.—"That in view of the importance to British Trade and Commerce of the operations of the Imperial Institute, more especially in investigating methods of utilising the raw materials of the Empire, and the serious limitations at present imposed on this work by the inadequacy of the Grant made by the Home Government, representations should be made to the Government urging the need of a contribution more in proportion to the value of the services which the Imperial Institute is rendering, and could still more largely render, to the development of inter-Imperial trade."

Extract from letter to the Prime Minister from the Association of British Chambers of Commerce, 1918.—"I am to say that this Association has had for some time a Committee, working in collaboration with the Imperial Institute, investigating the question of supplies of raw materials for industries in this country. The Association desires to submit that, in consequence, it has knowledge of the needs of this Institute, and, in view of the importance to British Trade and Commerce of the operations of the Institute, more especially in investigating methods of utilising the raw materials of the Empire, and in view of the serious limitations at present imposed on this work by the inadequacy of the Grant made by the Government, it is of opinion that a financial contribution more in proportion to the value of the services which the Institute is rendering, and could more largely render to

inter-Imperial trade, should be granted. I am to express the hope that this recommendation will receive your most favourable consideration."

Imperial Institute Advisory Committee on Raw Materials (including Representatives of Chambers of Commerce), 1919.—" The Raw Materials Committee of the Imperial Institute, which includes commercial representatives nominated by the principal Chambers of Commerce and the Federation of British Industries concerned with the trade in raw materials, have held meetings at the Imperial Institute since 1917.

" The Committee have been in close touch with the work of the Imperial Institute in discovering new sources of raw materials and in ascertaining the commercial value of new raw materials from overseas.

" At their meetings the Committee have received and discussed reports of this work conducted at the Imperial Institute, and have suggested any further action required to promote commercial development.

" The Committee therefore serve as a useful link between the Imperial Institute and the chief centres of commercial activity throughout the country. A number of results of importance to British trade and manufacturing industries have been already obtained, and are given publicity to in the journals of Chambers of Commerce and elsewhere.

" The Committee are strongly of opinion that the Imperial Institute as the central establishment for information and investigations respecting commercial outlets for raw materials should receive adequate financial support from His Majesty's Government. If this support is afforded the Committee are convinced that the Imperial Institute will be in a position to play a still more important part in the future development of inter-Imperial trade."

Imperial Institute Advisory Committee on Raw Materials, 1921.—" The Imperial Institute Raw Materials Committee, nominated by the Association of British Chambers of Commerce, understand that a Departmental Committee has been appointed to consider the housing at the Imperial Institute of the War Museum now at the Crystal Palace. It is announced that the necessary space may be found at the Imperial Institute.

" The Committee trust that in this connection the position of the Empire Collections in the Exhibition Galleries of the Imperial Institute will be safeguarded. The provision of these Collections is one of the principal objects for which the Imperial Institute was erected and endowed.

"The Committee desire strongly to urge that these Collections should be maintained on public, educational, and commercial grounds, and also that further steps should be taken to increase them and make them better known throughout the Empire.

"These Collections have been of the utmost value to the operations of the Raw Materials Committee in assisting the development of inter-Imperial Trade and Commerce in Empire Raw Materials."

Association of British Chambers of Commerce, 1921.—"That the Council of the Association of British Chambers of Commerce desires to represent to His Majesty's Government that in considering what should be done with the War Museum, no arrangements should be made which will interfere in any way with the Empire Collections at the Imperial Institute.

"The Association believes that the Collections should be maintained and increased, not only on account of their importance to the commercial operations of the Institute, with which the Association is directly connected, but also on account of their value for educational purposes in the principal City of the Empire."

Liverpool Chamber of Commerce, 1921.—"(1) That the Council of the Incorporated Chamber of Commerce of Liverpool are of opinion that the War Museum does not fulfil any useful purpose whether educational or otherwise, and as they are informed that the said Museum is costing the Treasury a large sum of money per annum, which can ill be spared in the present financial position, it ought to be discontinued.

"(2) That if for some good reason not apparent to the Council of the Chamber, the Government desire to continue the War Museum the Council consider that it ought not to be housed at the Imperial Institute for the following reasons, namely:

(*a*) The Objects of the Imperial Institute as set forth in the Charter do not include anything which would admit of such Museum being housed within its walls.

(*b*) Space could apparently only be found in the Imperial Institute by the removal in part or in whole from public exhibition of the Collections illustrative of the general resources and products of the Empire which have been and will continue increasingly to be of very great value, not only to the general public and to students, but also to the Commercial Community, whether Merchants or Manufacturers.

"(3) That copies of the aforegoing Resolution be sent to the Prime Minister, H.M. Chancellor of the Exchequer, the President of the Board of Trade, H.M. Secretary of State for the Colonies, and the High Commissioners in London for the Dominions of Canada, Australia and New Zealand."

Manchester Chamber of Commerce, 1921.—"Having been informed that a suggestion has been made to transfer the War Museum (now housed at the Crystal Palace) to the Imperial Institute, the Manchester Chamber of Commerce, which is interested in and represented on the Raw Materials Committee of the Institute, record their strong disapproval of the proposal.

"The Exhibition Galleries of the Institute are at present occupied by Empire Collections which serve a most useful purpose in developing the resources of the Empire in raw materials.

"The Chamber considers that the transfer of the War Museum to these Galleries would seriously interfere with the usefulness of the Empire Collections (already somewhat hampered by limited space), and would militate against the commercial interests of the Empire.

"The Chamber therefore urges that nothing should be done to encroach upon the space now so advantageously utilised by the Institute for purposes which represent one of the chief objects of the creation of that organisation."

Glasgow Chamber of Commerce, 1921.—"That the Directors of the Chamber of Commerce and Manufactures in the City of Glasgow have been informed that a Departmental Committee has been appointed to consider the question of removing the War Museum at the Crystal Palace to the Imperial Institute.

"That if His Majesty's Government desire to continue the War Museum the Directors are strongly of opinion that it ought not to be housed at the Imperial Institute.

"That the Directors believe that space could only be found in the Imperial Institute for the War Museum by interfering with the Collections illustrative of the resources of all the countries of the Empire.

"That these Collections are of great importance in connection with the investigation of raw materials, and are also of great value to commercial enquirers and to the general public.

"That the Directors accordingly protest against any attempt to interfere with the Collections on exhibition at the Imperial Institute, and resolve that the Prime Minister, the Chancellor of the Exchequer, the President of the Board of Trade, the Secretary of State for the Colonies,

and the High Commissioners in London for Australia, New Zealand and South Africa be communicated with accordingly."

Bristol Chamber of Commerce, 1921.—"That the members of the Council of the Bristol Chamber of Commerce hear with surprise and regret that it is proposed to transfer the War Museum from the Crystal Palace to the Imperial Institute. They would strongly deprecate this step if in any way the important and useful work for which the Imperial Institute was founded is to be interfered with."

RESOLUTIONS PASSED BY TECHNICAL ADVISORY COMMITTEES

Raw Materials Committee

A Resolution passed unanimously at a meeting of the Committee held on 3rd July, 1919, is printed on p. 250.

Advisory Committee on Timbers

The following Resolution was passed unanimously at a meeting of the Committee held on the 24th July, 1919:

"The Advisory Committee on Timbers desire to record their opinion that in the interests of the trade and industry of this country the operations of the Imperial Institute should be more amply endowed by the Home Government. The Committee include, besides architects and builders, representatives of the principal branches of the timber trade and manufacturing industries.

"Since 1917 the Committee have been engaged in considering the timbers of the various countries of the Empire and selecting for detailed examination those which appear to be suitable for constructional or decorative use in this country and which are known to be sufficiently abundant in the countries of origin to meet commercial demands. In due course the Committee propose that the timbers which they have ascertained to be suitable for these purposes shall be so indicated in architects' specifications, and in this way brought into commercial use, suitable steps being also taken to bring these timbers to the notice of all branches of the trade.

"The Committee have made considerable progress in this work, which necessitates the collection of a large amount of special information and the conduct of experimental work at the Imperial Institute, in which the members of the Committee and other bodies are actively co-operating.

"The task of the Committee is a large and important one, which has not before been undertaken on these lines.

"The Committee therefore trust that adequate funds will be provided to support the work of promoting the increased employment in this country of timbers of Empire origin and developing the new sources of supply which are so urgently needed."

(*Signed*)

H. D. SEARLES-WOOD (*Chairman*), F.R.I.B.A. Nominated by the Royal Institute of British Architects.

WALTER BIRCH (Messrs. William Birch, Ltd., High Wycombe). Nominated by the National Federation of Furniture Manufacturers.

W. E. VERNON CROMPTON, F.R.I.B.A. (Messrs. Lander, Bedells and Crompton, London). Nominated by the Royal Institute of British Architects.

JAMES S. HOLLIDAY (Messrs. Holliday and Greenwood Ltd., London). Nominated by the Institute of Builders.

WALTER LAWRENCE (Messrs. Walter Lawrence and Son, London). Nominated by the Institute of Builders.

C. J. MORGAN (Messrs. Foy, Morgan & Co., London). Nominated by the Timber Trade Federation of the United Kingdom.

PERCY PRESTON. Nominated by the Carpenters' Company.

KEITH PRICE (Messrs. Price and Pierce, London).

JAMES RICHARDSON. Nominated by the Timber Trade Federation of the United Kingdom.

W. H. SADGROVE (Messrs. Sadgrove & Co., London). Nominated by the National Federation of Furniture Manufacturers.

DIGBY L. SOLOMON, A.R.I.B.A. (Messrs. Lewis Solomon and Son, London). Nominated by the Royal Institute of British Architects.

Advisory Committee on Silk Production

The following Resolution was passed unanimously at a meeting of the Committee held on the 2nd July, 1919:

"We the undersigned commercial members of the Advisory Committee on Silk Production desire to accord our full support to the Executive Council of the Imperial Institute in representing that the operations of the Institute should be more adequately endowed by the Imperial Government in the interests of Commerce and Industry.

"We are particularly concerned with the silk manufacturing industry, and we are satisfied that great benefit will be secured to this industry from the results of the work with which we have been associated since 1917. This work chiefly consists in exploring new sources of silk supply within the Empire, and in testing the merits of the raw materials producible. The members of the Committee come up at their own expense from all parts of the country to attend meetings and give gratuitously a large amount of time and attention to these problems. They therefore trust that the Government will provide adequate means for the necessary work at the Imperial Institute to be efficiently carried out."

(*Signed*)

FRANK WARNER (*Chairman*) (Messrs. Warner and Sons, London). Nominated by the Silk Association of Great Britain and Ireland.

FRANK J. FARRELL (Messrs. Grout & Co., Ltd., Great Yarmouth).

WILLIAM FROST (Messrs. William Frost and Sons, Ltd., Macclesfield). Nominated by the Silk Association of Great Britain and Ireland.

J. SUGDEN SMITH (Messrs. John Hind & Co., Ltd., Wyke, Bradford). Nominated by the Silk Association of Great Britain and Ireland.

RICHARD SNOW (Messrs. Windley & Co., Nottingham). Nominated by the Silk Association of Great Britain and Ireland.

A. JOHN SOLLY (Messrs. Reade & Co., Ltd., Congleton). Nominated by the Silk Association of Great Britain and Ireland.

H. SOLMAN (Messrs. John Heathcoat & Co., Tiverton).

WILLIAM STOKES (Messrs. Lewis Balfour & Co., London).

WILLIAM WATSON (Messrs. Lister & Co., Ltd., Bradford). Nominated by the Silk Association of Great Britain and Ireland.

Advisory Committee on Hides and Tanning Materials

The following Resolution was passed unanimously at a meeting of the Committee held on the 25th July, 1919:

"In reply to Lord Islington's request for a statement of their views on the value of the operations of the Imperial Institute, especially to British Trade and Commerce, the commercial members of the Hides and Tanning Materials Committee wish to state that in the first instance the

Committee was appointed in 1916 to consider the possibility of utilising within the Empire the raw hides of India, which before the war were chiefly taken by Germany and Austria.

"The Committee have been in continuous session since then and have made several reports. The Committee include representatives of the tanning industry, one of whom is Chairman of the United Tanners' Federation, and representatives of commercial firms operating in India. In the course of their work the Committee have been in constant communication with the United Tanners' Federation, and with various organisations of the leather trade, as well as with individual firms of tanners and merchants. The enquiries of the Committee have in addition necessitated communications with the Government and commercial firms in the Dominions, and have also involved the general question of the production and export of hides from British Possessions.

"The Committee have received throughout most valuable assistance from the Imperial Institute and from the technical staff, by whom the detailed work of the Committee has been conducted.

"We have been glad to give our services in an honorary capacity in support of the aims of the Institute, as we are satisfied of their importance to the leather trades and industries of this country, which have been in the past too much dependent on foreign supplies of hides and other materials.

"We therefore trust that the Home Government will give adequate endowment to the Institute, as we feel sure from the knowledge we have gained of its operations that it is capable of rendering essential assistance to British trade and industries by promoting the utilisation of the raw materials of the Empire."

(Signed)

H. PERCY DENSHAM (Messrs. William Mortimer & Co., Ltd., Warrington). Chairman of the United Tanners' Federation.

SAMUEL MILLAR (Messrs. Millars, Ltd., Glasgow).

W. L. INGLE (Messrs. W. L. Ingle, Ltd., Leeds).

W. E. COOPER (Messrs. Cooper, Allen & Co., Ltd., Cawnpore).

CECIL GRAHAM (Messrs. W. Graham & Co., Glasgow, and Messrs. Grahams & Co., London).

CECIL JOHN LONGCROFT (Messrs. David Sassoon & Co., Ltd., London and Calcutta).

C. W. DAWSON (Messrs. Allen Bros. & Co., Ltd., London).

EXTRACTS FROM LETTERS OF APPRECIATION FROM VARIOUS SOURCES

The Governor, Seychelles. (6th March, 1923).—" I venture to ask for the help and advice of the Imperial Institute in this matter ; the reports on other subjects which the Colony has received from the Institute have invariably proved of the greatest value to those concerned."

F. W. Foxworthy, Forest Research Officer, Federated Malay States. (27th December, 1922).—" I am in receipt of your letter with reference to information as to firms able to supply hand-power machines for grinding the leaves of gutta percha trees. The information furnished is quite comprehensive and will be very useful. I wish to thank you for the trouble that you have taken and the information supplied."

The Canadian Government Trade Commissioner, Manchester. (22nd December, 1922).—" Permit me to thank you sincerely for the very valuable information [on West Indian fruit trade] contained in your letter of December 20th. It is just the information I needed and I shall certainly make good use of it."

The Director of Agriculture, Salisbury, Rhodesia. (21st December, 1922).—" Accept my thanks for your letter of the 17th November, covering a memorandum on the Meat Industry of Madagascar. This interesting report is being circulated amongst the members of the Committee of Enquiry into the Cattle Industry of Southern Rhodesia at present sitting, and the interesting information you have furnished was most timely."

The Director, National Botanic Gardens, Kirstenbosch, Newlands, Cape Town, South Africa. (20th December, 1922).—" I have the honour to acknowledge the receipt of your letter of the 27th November conveying the results of the tests on the leaves which we sent you. I am much obliged for the report on *Digitalis purpurea*, which is of considerable interest, and will be of assistance in bringing the matter before the manufacturing chemists in this country if we should have occasion to do so."

The Farmers' Co-op., Ltd., Salisbury, Rhodesia. (7th December, 1922).—" We are much obliged for the courtesy received from you regarding velvet beans, and also in the past, and compliment you on the good work which your Institute is doing."

The Editor, Journal of Industries, Pretoria, South Africa. (22nd November, 1922).—" As the Bulletin of the Imperial

Institute is consulted a great deal, it is desired to have the files complete, and I would accordingly be greatly obliged if you could spare us a copy of the issue in question."

S. A. Woodhead, Public Analyst's Laboratory, Lewes. (19th September, 1922).—" If you will kindly let me know your fee, I shall be glad to remit per return, as such definite information and reference [regarding beans] is very valuable to me."

The Chief Secretary to Government, Nyasaland. (2nd June, 1922).—" I am to state that the Nyasaland Government and the local Chamber of Agriculture and Commerce is much indebted to the Imperial Institute for the trouble which has been taken in this matter of the manufacture of nicotine, and for the valuable information which has been supplied. In view of the report it is unlikely that any attempt will be made to manufacture nicotine in Nyasaland or to grow the new leaf for sale as such."

Sir Francis Newton, Rhodesia. (19th December, 1921). " Regarding the red earth you have been good enough to report on for me, I may inform you that I sent your report to Messrs. Hubbuck of Lime Street, who are paint manufacturers, and they told me they thought it was an admirable report, and hoped I would tell you so, which I accordingly do. I am very much obliged to you for all the trouble and time you have given me on this matter, and for your valuable information."

The Curator, Mining Museum, Sydney, New South Wales. (6th December, 1921).—" I am very grateful for your letter of 20th October enclosing samples of abrasives. These we have tested and find both to be very good—quite equal to ' 303.' Please accept my very hearty thanks for the trouble you have taken in this matter."

Stafford Allen and Sons, Ltd., London. (24th November, 1921).—" With regard to the experimental batch of Cinnamon Bark distilled by us for the Imperial Institute, we have pleasure in stating that following up the experiments then initiated, we have been able to obtain an increased yield of oil on a manufacturing scale corresponding to the yield obtained on a small scale in the Imperial Institute's Laboratories."

Atlas Preservative Co., Ltd., London. (5th October, 1921).—" In accordance with the request contained in your favour of 22nd September on Xanthorrhœa resin, we have pleasure in advising you that we have ascertained that the two firms you were good enough to mention to us are in a position to supply us with the material if and when required. We procured a copy of the Institute Bulletin

you were kind enough to mention, the information in which is of great assistance in regard to the properties of the material. Again thanking you for your courtesy."

The Yorkshire Dyeware and Chemical Co., Ltd., Selby. (23rd September, 1921).—"The information given [on ebony] is exactly that we were in need of and we believe the same will prove very useful to us."

The Trade Commissioner, Government of the Union of South Africa, London. (19th September, 1921).—"I am directed by the High Commissioner to acknowledge with thanks the receipt of your most informative and valuable letter of the 17th instant on the subject of wood distillation products."

Keep Brothers, Ltd., Birmingham. (26th August, 1921). —"We are in receipt of yours of the 25th instant respecting the samples of coconut leaf fibre which we sent you for a report. This is very valuable, and we are much obliged for the care you have taken in the matter, although naturally the result from a commercial point of view is disappointing."

Boving and Co., Ltd., London. (7th July, 1921).—"We are obliged by your letter dated the 6th instant on the extraction of oil from fresh coconuts, and wish to express our thanks for the trouble you have taken and for the very valuable and helpful information you have so kindly sent us. We are studying this with great interest."

New Zealand Government Offices, London. (17th May, 1921).—"I thank you very heartily for your kindness in going to so much trouble to ascertain for my friend the information you conveyed in your letter of the 13th instant, regarding the papers by the Rev. Richard Baron. I am the more grateful because now I am able to place Monsieur L. Girod-Genet on the track of these publications, for which he made enquiry unsuccessfully over ten years ago through other sources, and the value of your Institute has been very much emphasised."

The Director, Government Analytical Laboratory, Cairo. (8th May, 1921).—"I beg to thank you for the cement report sent under cover of your letter of the 4th February last. The results of the tests and your comments thereon have been of big value to this Department."

The Potash Supply Company, London. (31st March, 1921).—"We have to acknowledge receipt of your esteemed favour of the 29th instant, and to express to you our appreciative thanks for the very full reply you have given to our somewhat troublesome enquiry in regard to potash

from Nigeria. The information you give is very useful to us."

The Director of Industries, Central Provinces, India. (8th March, 1921).—" I am very much obliged to the Imperial Institute for their valuable report and the great trouble they have taken in determining by experiments the possibility of utilising the cotton stalks as a paper-making material.

" The information furnished in the Report will be of very great value to the Province and has been communicated to parties interested in this particular industry."

Federation of British Industries, London. (29th October, 1920).—" This information (on deposits of carbonate of barium) will prove of considerable use to us, and the trouble you have so kindly taken in the matter is very much appreciated."

The British South African Explosives, Limited, London. (13th September, 1920).—" We are very much obliged to you for your letter of 9th instant containing information as to the various raw materials for paper-making. These details will be very helpful to us and we are obtaining further information from the sources mentioned."

War Office. (17th July, 1920).—" Many thanks for your letter enclosing map and notes on coal in Teschen. It is very useful indeed."

Rowntree & Co., Ltd., York. (7th July, 1920).—" We thank you for your letter of July 2nd giving us a bibliography of Almonds, Orange Oil and Lemon Oil, which we find most useful. We also thank you for the courtesy extended to the writer on his visit to you."

The United Overseas Company, Ltd., London. (13th April, 1920).—" We are duly in receipt of your favour of the 12th, and are very much indebted to you for the information you kindly give us on the subject of Tea Seed Oil, which will be of considerable value to us."

Jurgens Colonial Products Ltd., London. (10th February, 1920).—" We beg to thank you for your letter of the 7th instant accompanied by sample of Cohune nuts and kernels, and much appreciate your help in this matter. The specimens you send will we think be sufficient for the collection at our Head Office and had it not been for your kind assistance we anticipate that it would have been difficult for us to have obtained the sample. Very greatly appreciating your courtesy, and hoping that some day we may be able to reciprocate. . . ."

Copleys Bank Ltd., London. (10th January, 1920).—"We have to acknowledge, with thanks, the receipt of your letter of yesterday's date on China Clay, and are much obliged for the information and statistics given therein concerning this material, which will be of considerable use to us in arranging possible business."

The British Water Power Development Co., Ltd., London. (30th December, 1919).—"We are very much obliged for your letter of the 23rd instant regarding Salt Deposits. This information will be extremely useful, and we hope shortly to study the references which you have gone to so much trouble in obtaining for us."

Grahams & Co., London. (27th November, 1919).—"Very many thanks for your yesterday's letter on the subject of the production of Chrome salts in India. The information you give is most interesting, and I am passing out a copy of your letter to our Calcutta friends to-day, and I am sure they will be very grateful for the information that it contains."

W. J. Beatty, Northampton. (27th August, 1919).—"I beg to acknowledge receipt of your letter of the 26th instant and thank you for the very valuable information contained therein with reference to the Trinidad Pitch Lakes and Oil Fields, and the Geological Structure of Trinidad. The information you give is exactly what I required."

The Director of Agriculture, Gold Coast. (28th July, 1919).—"I have the honour to acknowledge receipt of your letter of the 2nd July [on the subject of Strophanthus seeds]. The price received is highly gratifying, has exceeded all expectations, and indicates possibilities for this product in the interior even if the price is much higher, as you say, than would be normally obtained, and I have to thank you for the care and interest you have shown in this consignment."

The Consolidated Gold Fields of South Africa, London. (26th July, 1919).—"I wish to thank you for the information concerning exports of rubber from Rhodesia and British East Africa, at the same time to express my appreciation of the value of the Imperial Institute for obtaining statistics of this nature. I have previously had occasion to obtain information indirectly, and consider that the Institute is of the utmost value to the commercial and professional element in this country."

The Co-operative Wholesale Society, Manchester. (15th July, 1919).—"We thank you very much indeed for the

valuable information you have given us on linseed. We have found in a difficulty that by applying to your Institute you have given us information which it is almost impossible to obtain otherwise."

Keene and Ashwell, Ltd., London. (10th July, 1919).—"We are in receipt of the nuts of *Anacardium orientale*, which are quite sufficient for our present requirements. Please accept our sincere and grateful thanks for your kindness in helping us over a difficulty."

The Yorkshire Dyeware and Chemical Co., Ltd., Selby. (7th July, 1919).—"We have pleasure in acknowledging your letter of the 5th instant replying to ours of June 3rd, 1919, on the subject of Elaterite and Naphthenes. We very much appreciate the detailed information upon Elaterite which enables us to decide exactly what possibilities it possesses for our commercial use. We note that your enquiries about Naphthenic Acids are being pursued with a view to finding a source of supply."

The West India Committee, London. (6th February, 1919).—"I cannot thank you sufficiently for the valuable information contained in your letter [*re* Hæmatine crystals] of the 3rd instant, which is exactly what we require. I may mention that in writing to my correspondent in Jamaica I am giving full credit to the Imperial Institute for furnishing me with this information where other Government Departments failed."

Professor D. A. Gilchrist, Armstrong College, Newcastle-on-Tyne. (21st January, 1919).—"I greatly appreciate your full reply to my enquiry as to books on farming and fruit-growing in British East Africa. It is just what I wanted."

War Office. (31st July, 1918).—"I beg to acknowledge receipt of your letter dated 29th instant, enclosing a report on timbers, etc., from German and Austrian aeroplanes, submitted for your examination in March 1918. I am to thank you for your report, the detailed information in which will be of great value to this Department."

Hartley Farmers' Association, Hartley, Rhodesia. (25th June, 1918).—"I beg to acknowledge the receipt of your letter of the 13th March last on the subject of sunflower seeds. I am instructed by my Association to thank you for the very full reply to my enquiry, for which my Association is very grateful."

British North Borneo Co. (7th June, 1918).—"I am directed to acknowledge the receipt of your letter of the

4th instant transmitting a report on the sample of clay from Tawao, supposed to be kaolin, which was forwarded to you under cover of our letter of the 21st January last. I am to convey to you the thanks of the Court for the exhaustive examination made by the Institute and for the valuable information contained in the report."

W. E. Kingsford, Cairo. (28th April, 1918).—" Very many thanks for your letter of the 27th instant and the very useful information you have kindly given me with regard to the cultivation of sage, which will prove of value for the experimental area I am putting down."

Professor A. G. Perkin, The University, Leeds. (12th April, 1918).—" I am greatly obliged by your favour of the 8th instant enclosing copy of a list of Indian Dyes and Tans, for which please accept my best thanks. This is exactly what I require."

Major R. F. Ward, London. (9th April, 1918).—" I have to thank you for your letter of April 8th on Coffee and Sisal growing, for the information you so kindly give me, and for the references to further sources of information. Your letter exactly answers my questions, and I am very much indebted to you for your help and assistance."

War Trade Statistical Department. (30th March, 1918). —" I am directed to refer to your letter of the 28th instant on chemicals and to express thanks for the information contained therein; the fact that it was made available at such short notice renders it particularly useful."

Director of Special Intelligence, War Office. (9th March, 1918).—" I am to say that the reports received from you on this timber from captured German aeroplanes have proved of the greatest value, and a further portion of a German aeroplane propeller (No. 1575) is being forwarded under separate cover."

Sindall and Bacon, London. (21st February, 1918).— " We are very much obliged for the excellent samples of paper-making materials which you have sent for Mr. Sindall's lecture on Friday at the School of Economics. These not only illustrate the variety of material available for paper-making, but form a good testimony to the usefulness of the Technological Department of the Imperial Institute."

Director of Special Intelligence, War Office. (19th January, 1918).—" I am directed to acknowledge the receipt of your letter dated the 16th January enclosing a

report on the timbers from German aeroplanes submitted for examination. This report is of great value, and I am to thank you for the trouble you have taken in the matter."

Wood and Bedford, Leeds. (12th July, 1917).—" We duly received yours of the 9th instant, and we beg to offer you our best thanks for the information about South African Wattle Bark. This information, we feel sure, will be of great use to us."

The Government Geologist, Western Australia. (10th May, 1917).—" In reply to your letter of the 17th of March to the Under-Secretary for Mines, regarding molybdenum ores. . . . If I may be permitted to offer a suggestion, I would point out how useful it would be if your Institution could see its way to reprint in a separate publication all the articles in your Bulletin dealing with minerals, their uses, preparation for the market, etc."

War Trade Statistical Department. (20th April, 1917).—" I am directed to thank you for the letter of the 17th April in regard to the uses, and sources of supply, of magnesite. The 'magnesite sand' referred to in the enquiry made by this Department was the name apparently applied, perhaps incorrectly, to indicate magnesite of sedimentary origin as opposed to magnesite of intrusive origin. In any event, however, the valuable information contained in your letter covers all the points with which the Department is immediately concerned."

War Trade Statistical Department. (28th February, 1917).—" I am desired to thank you for your letter of the 26th instant and its enclosures on the subject of sodium chromate and sodium bi-chromate. I am to say that the information which you have been so good as to furnish will be of great assistance to this Department."

Geo. E. Wade, Amanzimtote, Natal. (9th December, 1916).—" I have to acknowledge receipt of your letter and desire to express my thanks for the very detailed information you afforded me on the subject of paper-making from sugar-cane refuse. The letter was of great interest to me, and the information in it exceedingly useful."

British and Foreign Metal Co., Ltd., London. (8th September, 1916).—" We beg to acknowledge the receipt of your valued favour of 7th instant in reply to ours of 23rd ulto. We are indebted for your kind and prompt attention to the questions on the reduction of lead oxides asked by us, and now beg to tender our many thanks for the exceedingly useful information you have given us."

Harrison Brothers, Ltd., Middlesbrough. (14th July, 1916).—" We are duly in receipt of your letter of the 14th instant on the subject of corundum from South Africa, contents of which we have carefully noted. We are communicating with Messrs. Hale and Sons direct, and meanwhile take this opportunity of expressing our thanks for the kind attention you have given us in connection with this subject. We can assure you it is much appreciated."

The Hon. Secretary, National Federation of Furniture Manufacturers, London. (6th July, 1916).—" Allow me to thank you for your reply of the 5th instant [on the subject of the trade in mahogany and mahogany-producing countries] which is exactly what I require. May I compliment you on the promptness of your reply and the care which you have taken."

Anchor Cable Co., Ltd., Leigh, Lancashire. (26th June, 1916).—" We thank you for your letter of the 21st instant [regarding means of preventing the attacks of termites] and wish to say that from the information given we may be able to manufacture a satisfactory cable for this purpose."

W. J. Craven & Co., Evesham. (2nd June, 1916).—" Reverting to the question of the matter of your letter of May 19th as to the origin of the gypsum we submitted to you, you will be interested to know that the information you kindly supplied to us has been of greatest service. We got at once into communication with the people who supply the powder, and we had a delivery to-day of a truck-load. We greatly appreciate the help you rendered us in this matter."

The Royal Mail Steam Packet Co., London. (28th February, 1916).—" I beg to acknowledge receipt of your letter of the 26th instant, furnishing information in regard to the sugar industry in Egypt. I beg to express my best thanks for the useful and interesting information that has been communicated and to state that if there are some further definite particulars which I would like you to obtain I shall take advantage of your kind offer to make enquiries from the Minister of Agriculture at Cairo. In that case I shall communicate with you further."

Sir S. W. Royse & Co., Ltd., Manchester. (11th February, 1916).—" We beg to thank you for the most useful information on the subject of South African manganese ore contained in your favour of the 26th ultimo."

Arthur H. Hasell, Sydney, New South Wales. (29th December, 1915).—" We have to acknowledge receipt of your letter of the 9th November. Please accept our best

thanks for the full report you have given us on Diatomite. This report has brought home to us the value an Institute such as yours is towards initiating business between different parts of the Empire."

The Chemical Society, London. (9th November, 1915). "Your letter of the 3rd instant has been duly submitted to the Council, and I am directed to convey to you an expression of their most appreciative thanks for the valuable information you have been good enough to send with regard to the utilisation of Xanthorrhœa resin. I am communicating with Mr. Macmillan in accordance with your kind suggestion."

Kleinwort, Sons & Co., Liverpool. (6th November, 1915).—"We have your letter of yesterday and thank you very much for the further very full information which you so kindly give us regarding the above article [West African Dika nuts]. We shall certainly order a copy of the Selected Reports issued by Messrs. Wyman, to which you refer, and thank you for this suggestion. We trust that our endeavours now to buy this article and thus promote the export of same from the African coast will ultimately result in success through your good help."

The Chemical Society, London. (15th October, 1915).—"Your letter of the 6th instant has been duly submitted to the Council and I am directed to convey to you an expression of their appreciative thanks for the information you have been good enough to send with regard to the uses made of floss derived from *Calotropis gigantea.*"

Cookson & Co., Ltd., London. (23rd August, 1915).—"We are much indebted to you for your kind letter of 21st instant on the subject of lead acetate and lead nitrate in connection with the cyanide process of gold extraction, the contents of which are noted with interest. The information given is of considerable service to us, and we are obliged to you."

Appreciations of the work of the Imperial Institute on Paper-making Materials, by Mr. J. L. Greaves, Editor of "The Paper Maker"

(1) Extract from speech at the Empire Press Union Conference at Ottawa, September 1920:

"I would further suggest that any gentlemen at all interested in the subject should get into touch with the Principal of the Imperial Institute, and he will get exact information going back twenty years. There is scarcely a fibre that has not been dealt with exhaustively and

elaborately. There you can see in cases almost every fibre that ever was heard of, in all stages from raw material to completion, and can examine the finished article and consider the most important factor which is generally lost sight of—the yield."

(2) Extract from paper on "Paper Making, Ancient and Modern," read before the Scientific and Technical Circle of the Institute of Journalists, February 1923:

"At the Imperial Institute, South Kensington, very valuable work in this connection had been done for years past and he advised those who were at all interested in new fibres to pay a visit to the Institute, for there would be found a very large collection of fibres grown in the United Kingdom, the Colonies and India. These fibres had been tested with great care by experts, and the exhibits conveyed at a glance their value, which in this country at least was comparatively small in the majority of cases. Almost every "new" fibre was to be found in the collection at the Imperial Institute, and, as he mentioned at the Imperial Press Conference not very long ago, when this subject was discussed at some length, he advised all enthusiasts who discovered new fibres to visit the Imperial Institute and see for themselves the results of the very important work achieved in the research department of the Institute."

PUBLIC EXHIBITION GALLERIES

Extracts from Letters from Schools on Conducted Visits

"We appreciate so much the youngsters receiving first-hand information in contact with actual produce, etc., that we would like our school entered for the next series."

"The boys much appreciated their former visit to the Imperial Institute, and I very gladly avail myself of the opportunity of again sending a party."

"The last visit paid by our girls was greatly appreciated, and our best thanks are due."

"With thanks for success and pleasure of yesterday's lecture."

"If you have any schools dropping out, I will always be glad to fill the vacancies so caused, and at the shortest notices. I am very sorry that you cannot give us more of these lectures."

"The girls thoroughly enjoyed and appreciated the lecture on India in December."

"In reply to your letter received to-day I have to state that Friday is very inconvenient to us. Wednesday the 26th April would be much better, but rather than lose the opportunity altogether, we will try to arrange for Friday the 28th for 30 girls with teacher in charge."

"I am writing to ask whether it would be possible for us to have another date for a Guide-lecture on Canada this term. We have already had one, and during this and other lectures that I have brought boys they have derived so much benefit that another form of mine (studying Canada) is very anxious to come too."

"Would you mind letting me know what dates you could spare? If more than one are available I should be glad to know."

"I am greatly obliged to you for giving the boys an opportunity of attending one of the demonstrations again next season, for they are enjoyed immensely."

"The demonstrations we have already attended are highly appreciated by the boys and the teachers."

"Please accept my apologies for not writing earlier. It would be a cause of regret if my boys were not able to accept your kindness; they enjoyed the visit last year so much and profited so much."

"We appreciate very highly this opportunity."

"I hope that in future you will allow me to take advantage of the demonstrations."

"Our last visit was very much appreciated by all, and if we can be given an opportunity of a Guide Lecturer in the summer term I shall be much obliged."

"I am most grateful to you for giving our girls another opportunity of hearing a most instructive lecture."

"I take this opportunity of assuring you that our boys much appreciate the efforts made by your organisation for their benefit."

"Also I should be very glad if you can possibly give us another date."

"If you can give me two dates, I shall be very pleased. I find that the demonstrations are of tremendous value, and very popular."

"We are only too grateful to be able to participate in these lectures."

"Has it been possible to give me the extra date I asked for?"

"My teachers and myself are very glad you can allow us the opportunity as we find the visits under the guidance of your Lecturer most valuable. We shall be pleased to make use of any further dates which it may be possible to allot to us."

"I want to thank you for the very interesting and instructive lecture on New Zealand given to the children last Thursday. They came back delighted with all they had seen and heard and, judging by the good accounts they wrote afterwards, they had learnt a great deal. That particular class has been studying the British Colonies this year so any time the lecturer has a spare afternoon I should be most grateful for the girls to hear a lecture on Canada."

"If there should be any vacancies for New Zealand and Fiji and Western Pacific we should like one or both, please. Should you find it impossible to allocate these, perhaps you can arrange a Saturday date for us."

"Our boys have warmly appreciated their visits to the Imperial Institute lectures, and I assure you that nothing but stern necessity would cause me to deprive them of such an educational advantage."

"Our school examinations will be in progress during that week, but as I know there is great competition for the privilege of attending, I am glad to accept that date for this school."

"I take this opportunity of saying how much we appreciate these lectures . . . tending as they do to make the places the children read about *really live.* The last lecturer on Nigeria and West Indies was exceedingly sympathetic in his outlook on boys' nature and vision."

"Our last visit was a great joy to the children, and we should like to express our thanks to the lecturer for his thoroughly interesting lecture and his patience with the children."

SPECIAL ARTICLES FROM THE PRESS ON THE WORK OF THE IMPERIAL INSTITUTE

The following is a reprint of an article by a Special Correspondent of *The Times* which appeared on 16th January, 1922.

"EMPIRE TRADE TEACHING

"It has been the work of many years to bring the Exhibition Galleries of the Imperial Institute to anything like the representative standard contemplated by the founders. All this time the productions and trade of the Empire have been increasing; the difficulties, financial and other, have been great; and only to-day can it be said that the collections illustrate our Imperial resources. If in one sense they are now complete, it must be remembered that they can never be considered final as long as the Dominions and Colonies continue to develop. Every country in the Empire has assisted, while the King and Queen have taken a personal and active interest in the equipment of the Galleries. The Prince of Wales allowed the presents and addresses received from the Dominions and Colonies he had visited to be specially shown, and these are now to be included in the permanent exhibition. Among the many who have taken advantage of what the Galleries have to teach is Princess Mary.

"Princess Mary, hearing of the guide-lecturer, gathered a party of her friends, and in a series of visits toured the Empire in the way the Galleries enable one to do. Her example is followed by people generally and by schools. Already over 4,000 boys and girls from elementary, secondary, and public schools have been with their teachers or have followed the guide-lecturer on the special days arranged for them. The demand, both from schools and the public, is indeed greater than can be met by the present arrangements. Parties were at first limited to 20, which had to be increased to 25, and then further extended to 30; and even so the services of one member of the staff who can be spared to act as conductor are insufficient to the requirements. Economy has hitherto prevented the opening of the Galleries on Sunday, and caused their early closing in the dark months. There are many visitors who use the collections for trade purposes and for information on countries they intend to visit or settle in. Apart from this public employment, the Galleries form the starting-point for researches by the staff for the utilisation of the raw materials of the Empire, which were described in a former article on the Imperial Institute in *The Times* of December 2.

"Nowhere else under one roof can one get so wide an insight into the present position and resources of all the countries in the Empire. There is no exaggeration in saying that a week in these Galleries—a week, because there are many of them, and they are long—would provide the apt student with more direct, exact, and assimilable knowledge

than can be gained by years of travel. Travel, of course, brings experience which no examination of exhibits can give. But exhibits can be so arranged and supplemented as to impart some of the pleasant novelty of going about the world ; and this is the method adopted at the Imperial Institute.

"To each country, or group of countries, is allotted a section of its own. There are displayed, under glass, specimens of its products and the multifarious articles into which they are manufactured, while labels supply clear information of their constitution, properties, and uses. Near the specimens are large photographs, paintings, or transparencies on the windows, of the lands they come from and the native inhabitants. Large-scale maps hang on the walls for consultation, and diagrams of every possible ingenuity show the course of production and trade through the years. South Africa, New Zealand, Victoria, and South Australia are among the countries which have recently added to and improved their exhibits in the Galleries. Canada is spending a large sum on the complete reorganisation of the Canadian section ; the Crown Colonies and Protectorates have shown increased interest, and one of the results seems to be a healthy rivalry in inventing the best methods of Imperial advertisement.

"A few examples must suffice. They range from large oil paintings of Canadian scenery, homesteads, and cattle to the pile of gilt cubes (each representing 10,000 oz.) which keeps pace with the South African output of gold. Between these two extremes are models of towns and harbours, of the mechanical device by which New Zealand frozen meat is loaded in the ships, of the working of the Kimberley diamond mine, of a hundred other things and places. In one large case can be seen Canadian fruit preserved in a special liquid which keeps strawberries red and peaches bloomy for an indefinite period. In the next are apples, pears, and plums imitated so exactly in wax that nobody could tell they were not real unless he tried to eat them. The new Egyptian section, not yet complete, in which the delegates recently in London are said to have shown a very proper pride, contains beautiful specimens of carpet and wood-work, in addition to a fine collection of Egyptian cotton, and among the treasures of the Sudan are models of the grain market at Omdurman and of Port Sudan, so hot and sandy, when the electric light is switched on, that one feels positively there.

"These are not mere prettinesses, but aids to the imagination. They contribute their legitimate share to

the great variegated picture of the Empire, in its general as well as its commercial aspect, which is the purpose of the Galleries. They complete the story of the plant or mineral from its beginnings in nature to its end in the service of man. Thanks to them, the visitor can study the land whence comes the thing he is concerned with, the appearance of the folk who help to cultivate or mine it, the houses they live in, the clothes they wear. It is like a vast panorama, rigidly accurate, variously charming. To view it is to increase enormously one's perception of the wealth of the Empire, suggested here by a pile of bright tins containing preserved fruit or fish, there by a piece of pottery, and yonder by columns of timber meaning both furniture and paper. These Galleries were one of the principal objects for which the Imperial Institute was started, and the Director has had a big task in bringing together, arranging, and describing the exhibits from every quarter of the globe.

"The extensive Indian section is enriched by many loans from the King and Queen. Some of these are exquisite specimens of native art and handicraft, presents to their Majesties during their Indian visits and on other occasions, work in wood and metal, fibre, ivory, and silk. An example of old Indian carving occurs in the pillars and door from a house in Lucknow, half burnt during the Mutiny, and preserved here for their historical and industrial significance. The intention is a reminder that even in this section devoted to Indian industries the chief aim of the Galleries, the severely or æsthetically practical, is never missed. A few steps away you get the reminder again. A case of exquisite little things in bronze testify to the cleverness of Burmese boys under European instruction. Their teacher is an enthusiast, and their work vindicates him. Then, in the Ceylon Pavilion, designed and decorated after the Cingalese fashion, at the instance of the Ceylon planters, comes a kindred lesson in the variation of civilisation. The Pavilion may be a relation of the neighbouring Galleries, but it demonstrates the independence of the art of Ceylon and illustrates the growth of Ceylon industry.

The Imperial Institute needs more space. It is cramped by the arrangement of earlier days that made it the host, as to much of its accommodation, of the University of London. Yet there is a proposal—perhaps it is no more than a rumoured proposal—to overwhelm it with the Imperial War Museum, when that leaves the Crystal Palace. To judge of the wisdom of crushing out, or even crippling, the Galleries, it is only necessary to go through them."

The following is a reprint of an article from *The Daily Telegraph*, Wednesday, 19th April, 1922:

COURTS OF EMPIRE

THE IMPERIAL INSTITUTE, BY SIR WILLIAM SCHOOLING, K.B.E.

"Portugal and Spain, France and Holland, had established colonial empires before the expansion of England began; and the English, while the last to found an Empire overseas, were the first to lose it. The duration of that first Empire lasted from the colonisation of Virginia in 1606 to the year of American Independence. The loss of the New England Colonies left the British with comparatively few possessions overseas, but since those days so vast an Empire has been built up that we have almost forgotten the lateness of our start, the failure of our first effort, and the salutary lessons which attached to it.

"The early adventures of European nations were mainly stimulated by the desire to obtain the real and fabled wealth of the East. They were also largely dominated by the idea that the best road to the East was across the Western Sea. When Columbus reached the coast of America he thought he had reached the shores of India, and consequently called the natives 'Indians.' The explorers of the North American continent persisted in their efforts because they hoped to find on the other side a narrow Western Sea, across which were the shores of China and Japan. Their geographical notions were mistaken, but they unexpectedly found in the new countries sources of wealth and welfare greater than any that could have been reaped from the realisation of their wildest hopes of the riches of the East.

"If individuals were greedy for wealth, and if we choose to say that such greed was a somewhat ignoble motive, we must recognise on the other hand that this was counterbalanced by a splendid spirit of adventure, by countless hardships and acts of bravery, and, as events turned out, by discoveries of far-reaching value and importance for the British race.

"*Wealth and Welfare*

"For Governments, at any rate, it is appropriate to seek the increase of national wealth, for nothing is clearer than that the development of the commerce, industry and wealth of a country increases the welfare of its people. As we study the history of colonial administration, we are

continually struck by the selfish attitude of the Mother-country, by the failure to understand the needs and the dispositions of the British overseas, and of the greater importance that was attached to political squabbles in Europe or in the United Kingdom than to the vastly more momentous concerns of our continually expanding Empire.

"It is only in comparatively recent years that larger and juster views have prevailed, and that great self-governing Dominions have come to take their rightful place in the affairs of the British Empire. Even to-day, however, the majority of the people in the United Kingdom know far too little of the history, the resources, and the geography of the outlying parts of the Empire.

"It was a happy inspiration of King Edward to bring about the foundation of the Imperial Institute as a memorial of the Jubilee of Queen Victoria. The familiar building at South Kensington was opened, but the methods of development at first adopted were not altogether successful. In 1903 the Institute was reorganised, and has since been carrying on three definite functions which, as they become more fully developed, cannot fail to prove of the utmost value to the Empire.

"*The Empire in Miniature*

"For the average member of the public the Exhibition Galleries are of the greatest interest. They provide a permanent display of the chief resources of all the countries of the Empire. Here we can see paintings and photographs of cities and towns, scenes of industry, natural features, and the mode of life of the various people. Here are displayed specimens of timber, minerals, plants, and other products of these British lands. As we wander through these Courts of Empire with an understanding and imaginative mind, we find them to be not only of absorbing interest, but to suggest almost endless possibilities of development for the benefit of the Empire at home and overseas.

"It is no criticism of the present Council of the Institute to point out how unworthy and comparatively trivial these exhibitions are. In the mere matter of space we find that the Dominion of Canada is represented by one square foot for every 300 square miles of territory, while Kenya, of which it is so important we should learn much, has but one square foot in which to represent the products and activities of nearly 700 square miles of territory.

"There are few developments of more importance at the present time for the benefit of the Empire as a whole and the United Kingdom in particular, than a well-planned system of emigration from the Home-country to the over-

seas lands of the Empire. For stimulating this, and for giving potential emigrants a clear understanding of the character and possibilities of each country, nothing could well be so serviceable as to make these Courts of Empire even more comprehensive and interesting than they at present are. It may be that for the moment such handbooks and descriptions as are available leave a good deal to be desired, but because the significance of Empire has not been adequately grasped, the Council has been systematically struggling with the difficulty of insufficient funds for all the activities which it would but too readily undertake if it could. Even as it is, it is a striking scene to witness groups of school-children being conducted round these Courts of Empire, under the charge of a guide-lecturer, who gives reality and vividness to the objects which are displayed, and can tell something of the nature and the possibilities of the countries from which they come. The Empire tends to become a reality to these young students, many of whom, it may be, will be influenced by these visits to the Imperial Institute to seek their fortunes overseas, to their own advantage and to that of the Empire as well.

" *Practical Research*

" The Exhibition Galleries, however, are only one feature of the work of the Imperial Institute. The pioneers of Empire, as we have said, were stimulated by the desire for the gold, spices and precious stones of the ancient East. The Imperial Institute is seeking equally, but by very different methods, to make available the as yet but little explored wealth of the Empire. It has a scientific and technical department equipped with extensive laboratories and workshops, for the investigation of raw materials and the uses to which they can be put. These studies are of an entirely practical kind. While working by the methods that modern science has placed at the disposal of the investigator, the problems dealt with are not those of scientific research, but of practical utility for the commerce and industry of the Empire.

" The Institute has been largely instrumental in proving that minerals which abound in various parts of the Empire can be utilised for many purposes, such as the manufacture of gas mantles and of special steels, and so industries have been developed which were previously in other hands. Numerous sources of paper pulp have been found throughout Africa, New Zealand and elsewhere.

" The Empire is extraordinarily rich in timber, and as we walk through the courts of the various countries we

can see the woods which each of them produce; and so we could pass from one subject to another, showing how, by investigation, by analysis, and by suggestion to experiment within the Empire on growing or producing things hitherto only found outside, the Institute has been developing various British countries and helping to expand the trade and industry of the Empire. In doing this it has the assistance of strong technical committees of manufacturers and experts of many kinds. One may be concerned with jute, wool, or other fibres, another with food grains, yet others with resins and essential oils; with drugs, tobacco, and spices; with hides and tanning materials; with mineral resources; with rubber; with silk production; and with many other subjects.

"Distributing Knowledge

"The investigations in the laboratories having given some promise of success, manufacturers in this country, or elsewhere, are invited to test the products, or the processes, on a commercial scale, and thus time after time new industries have been developed and new sources of wealth have been discovered.

"Not the least important of the activities of the Imperial Institute is the intelligence which it collects, reviews and distributes. It publishes a quarterly 'Bulletin' which gives a summary of the principal investigations that have been carried out, describes progress in the utilisation of raw materials and in the production of mineral, agricultural and forest products. Handbooks and monographs of minerals, vegetable fibres and other raw materials have also been issued and the Intelligence Department receives and answers enquiries that are continually being received from all parts of the world.

"The Institute is definitely Imperial, and receives support, financial and otherwise, not only from a small endowment of its own and from the Home Government, but from the Dominions and Colonies as well. Situated in London, the centre of the Empire, it is able to do, and it is doing so far as its scanty resources permit, work which cannot be accomplished elsewhere, and which is vital to the development of the resources and trade of the Empire. Much of the work can only be understood and appreciated by manufacturers and traders on the one hand, and on the other by those in distant lands who produce the various products, the value of which they learned for the first time from the thorough but unobtrusive work of the Imperial Institute.

"The Exhibition Galleries, however—the Courts of

Empire—can be appreciated by any visitor who will take the trouble to examine them with a certain modicum of intelligence, in spite of the fact that sufficient has not yet been done in the way of handbooks and descriptions to make the full significance of the exhibits readily and adequately appreciated. This lack, however, is made good when parties of people, especially perhaps of children, are conducted round the exhibition by a guide who will tell them the true meaning of the things they see.

"*The Imperial Institute*

"As a Government and as a people, we in Great Britain have as yet no conception of the characteristics and resources of the British Empire, and far too little of an intelligent and appreciative Imperial spirit. Much can be done to remedy these defects by making the fullest use of the Imperial Institute. With the knowledge that would thus be gained there would come a greater interest in, and sympathy with, the British overseas, with the result that the bonds of Empire would be more closely knit.

"If the work of the Institute is permitted to expand it will reveal untold sources of hitherto unsuspected wealth throughout the Empire, and by the application of the methods of science and the organised assistance of industries at home and abroad will enable the wealth of the Empire to be made available for its welfare. An advantage less tangible, but not of less value, is that the Institute may teach the significance of Empire to the people of the United Kingdom as well as to visitors from overseas. Not the least of the services that it may be able to render is the encouragement of a well-considered plan of emigration of men and women who have learnt beforehand the possibilities of the lands in which they propose to settle."

The following editorial notice is reprinted from *Nature* (1st April, 1922.)

"THE IMPERIAL INSTITUTE

"It is astonishing that, at a time when the Imperial Institute is looking forward to further developments in its work, a proposal should be put forward involving the dismantling of more than half of the recently extended and improved collections in the Public Exhibition Galleries of the Institute—without question the finest illustration of economic geography in the world—in order to make room for the war relics known as the Imperial War Museum at present housed in the Crystal Palace. *The Times* of 7th March contains special and leading articles

on the subject in which a clear case is made for the abandonment of the proposal. Attention is directed to the resolution of protest recently passed by the Executive Council of the Institute. While appreciating the desire for economy in housing the War Museum, the Council considers that this object should be achieved by some other method than by a plan which would be seriously detrimental to the development of educational and commercial work for which the Imperial Institute was erected and endowed. Resolutions of protest have also been received by the Council from a number of important bodies, including the Association of British Chambers of Commerce; the Chambers of Commerce of Liverpool, Manchester, Glasgow and Bristol; the Royal Institute of British Architects; the Timber Trade Federation; the Institute of Builders; and the Silk Association.

"For a quarter of a century the Imperial Institute, with very slender means, has been carrying on work of great service to the Empire, a fact far too little known and appreciated. The reward of such endeavour should be the provision of better facilities for development, and it is precisely in this respect that the proposals now put forward on behalf of the War Museum would be so detrimental in their effects. The Imperial Institute is becoming the recognised headquarters of organised effort in this country for the development of knowledge of the natural resources of the overseas countries of the Empire, and it is to be hoped that the Government will see that nothing of the character of the proposals justly condemned by *The Times* shall prevent the achievement of so desirable a purpose."

REVIEWS AND NOTICES OF PUBLICATIONS

Bulletin of the Imperial Institute

"These fifty-six pages are the first part of a systematic and comprehensive review of the agricultural resources and conditions in Cyprus. No such compendium has previously been available in the English language."—*Field.*

"With this end in view the quarterly Bulletin provides a store-house of information of very great value in pursuing the trade policy recommended two years in succession by the Imperial Conference.

"Mention should be made of the exhaustive monograph on the production and uses of rice published in the Bulletin of the Imperial Institute last year, for which there has been a large demand."—*Times of India.*

"In an article in the Bulletin of the Imperial Institute, Vol. xix, No. 3, an excellent account is given of the production of cinnamon in different parts of the world. . . . The article is of very full character."—*Perfumery and Essential Oil Record.*

"The publications of the Institute and the periodical bulletins of progress prove that India receives just as much attention as any other part of the Empire. Scarcely a bulletin reaches us in which we are not able to find some record of investigations carried out, enquiries made, advice given regarding the value and commercial possibilities of one or other of India's industries and products, especially those recently discovered or previously overlooked, in which further development may give desirable results."—*Madras Weekly Mail.*

"Bulletin of the Imperial Institute: This is indeed a record of progress, and contains much information of the greatest interest and value to textile men in whatever sphere of activity they may be engaged."—*Textile Recorder.*

"For years past valuable articles have appeared in the Bulletin, giving reports, for instance, on many tanning materials, few of which were known to our tanners, whilst we have often read of supplies of greases and oils suitable for leather work—in fact, our industry has been well treated by the Imperial Institute, in spite of the apathy with which it has been received. However, the Institute has carried on the good work in spite of all and in the April–June issue of the Bulletin—just published owing to war delays—we have before us one of the most complete summaries of the Indian hide and skin trade which it has been our lot to peruse.

"For this and other reasons we welcome the exhaustive survey of the matter in the Bulletin; it bears evidence of long and laborious investigation, as the work of collecting and collating the statistics alone must have entailed a very large amount of labour. It is obvious the first step towards effective post-war action in connection with hides and skins, as with other raw materials, is complete and accurate knowledge of the trade, and those of our readers who realise the immense importance of the future of the business will do well to make a careful study of the Bulletin article. It consists of upwards of seventy pages of well-printed matter and statistics, and deals exhaustively with Indian sources of the supply of hides and skins, estimates the present output in comparison with other competing countries, and discusses in detail the trade

figures in pre-war times and the changes in destination brought about by the war."—*Leather World.*

HANDBOOKS TO THE COMMERCIAL RESOURCES OF THE TROPICS

Oilseeds and Feeding Cakes

"Prof. Dunstan and his staff are to be congratulated on the bold way in which they have grappled with the problem and the lucid statement they have drawn up."—*Nature.*

"This contains the first series of 'Imperial Institute Monographs,' which are the outcome of the highly important work which the Institute has been doing since the war began in assisting the development of British industries. Particularly has the Technical Information Bureau, started just before the war, been increasingly busy in supplying information as to new markets, new or little-known materials, the utilisation of raw materials in foreign countries, and many other matters."—*Times.*

"The book is instructive in all aspects of the question."—*Field.*

"There seems to be no doubt that the industries in connection with all these substances are capable of very great expansion, and the publication of this volume ought to do a great deal to establish them firmly in Great Britain."—*Journal of the Royal Society of Arts.*

"Should be in the hands of all concerned in the trade in oil seeds and feeding cakes, as well as the farmer and stock raiser."—*Chamber of Commerce Journal.*

"Touching . . . copra, palm kernels, ground nuts, sesame seeds, and mowra seed . . . it is scarcely possible to conceive a more useful kind of commentary on or index to the industrial demands of to-day."—*African World.*

"This valuable publication cannot fail to be of special value at the present juncture, when every kind of human and animal food is becoming dearer."—*Oxford Times.*

"Within the compass of one hundred pages buyers will find a large amount of information dealing with the availability, cost, and nutritive value of these new materials, arranged clearly and concisely and in a most convenient form."—*Manchester Courier.*

Cotton and other Vegetable Fibres

"A good, useful book for all and every fibre man."—*Tropical Life.*

"Those interested in sisal planting will be compelled to

add this book, with Dr. Goulding's notes on sisal, to their bookshelf, as it is the only up-to-date work we have got. Besides having much to teach us about sisal, it also discusses other fibre-yielding plants in a manner that cannot fail to be extremely useful."—*Tropical Life.*

" It should prove of immense utility to those concerned in the various textile industries."—*Ceylon Observer.*

" The book contains a mass of information which should prove useful to all users of fibres."—*Asiatic Review.*

" ' Cotton and other Vegetable Fibres ' makes a timely appearance. It is eminently practical, dealing with the processes of growing and preparing for use not only cotton, but various other industrial fibres—flax, hemp, ramie, jute and flosses."—*Daily Telegraph.*

" The resources and possible capacities of the world are set forth with scientific thoroughness and accuracy and in statistical detail."—*Globe.*

" Gives in a very handy form a summary of the position and prospects of the world's production and utilisation of fibres . . . gives an excellent description of the cotton plant and its products."—*Journal of the Royal Society of Arts.*

" It materially assists the general reader to form an idea of the available resources for fibre production, and of the principal factors, favourable or otherwise, which dominate the situation."—*The Textile Manufacturer.*

" Dr. Goulding's work provides a valuable contribution to the information available in regard to the fibres of commerce."—*The Textile Mercury.*

" Although comprehensive, the matter is concise, and a vast amount of information—the result of arduous work—is packed between the covers. It would be impossible for us to deal adequately with the whole of this work, which would serve admirably as a book of reference to all the industries concerned."—*The Textile Recorder.*

Cocoa : Its Cultivation and Preparation

" Those owning established plantations, or who are thinking of taking up cocoa planting as an industry, will certainly need to add Mr. Johnson's work to their bookshelves, and when they do so they will find the information given to be compact, easy to understand and follow, sound in practice, and reliable in detail. We are glad to see such a book from so experienced an authority."—*Tropical Life.*

"The work, which is illustrated with numerous plates and statistical tables, is most exhaustive in nature, and contains all the information on cocoa and its production that a prospective planter in any part of the world could possibly require."—*Western Daily Press.*

"Lucid, workmanlike, interesting, and well furnished with photographic illustrations, the book forms a useful addition to the series in which it appears."—*Scotsman.*

"It may be recommended to the notice of those interested in the cocoa industry, as it contains a mass of information relative to planting and cultivation. Many valuable hints may be gleaned from its pages, which cover the subject in a thoroughly comprehensive and capable manner."—*Financial Times.*

Rubber: Its Sources, Cultivation and Preparation

"There is probably no person better qualified to write a handbook on rubber . . . a carefully compiled and extremely valuable textbook."—*West India Committee Circular.*

"To planters, manufacturers, merchants and students alike, the book should be invaluable as a guide to the scientific exploitation of rubber."—*African World.*

"The book is well illustrated, and written in an easy style, despite the botanical technicalities necessary to a book of this character."—*The India Rubber Journal.*

"It should be of special service to all who are engaged in the management of rubber plantations."—*Rubber World.*

"A useful detailed account of the present position of the rubber-producing industry, with particular reference to West Africa."—*Tropical Life.*

The Agricultural and Forest Products of British West Africa

"The book will be of value to all prospective officials in a part of the world that is rapidly coming to the front."—*Daily News.*

"The information given is thoroughly practical, and if the present book is a fair sample the series will be of high utility."—*Outlook.*

"The admirable arrangement of the present volume leaves nothing to be desired. Mr. Dudgeon has carried out his task with thoroughness, and the book is excellently equipped with maps, illustrations and index."—*Manchester Courier.*

"A remarkably interesting book."—*Liverpool Daily Courier.*

" So far from being a dry, technical treatise, Mr. Dudgeon's book will be found interesting even by the general reader."—*Athenæum.*

" The careful marshalling of facts and purports which Mr. Dudgeon has here got together cannot fail to be of great value to all concerned in the development of its natural resources."—*Western Morning News.*

" The book can be consulted with confidence as to the reliability of its statements, while the opinions and judgments expressed are those of a highly qualified and experienced expert, writing of things seen and known, and not merely repeating reports or hearsay at second hand."—*West Africa.*

Monographs on Mineral Resources

Potash (*Second Edition*)

" The work is valuable as supplying a comprehensive survey of the principal resources of potash supply throughout the world."—*Chemical Age.*

" All interested would be well advised to secure a copy of this important work. Mr. Sydney J. Johnstone handles his subject with marked skill, and the book is very well written."—*Metal World.*

" A welcome reissue of the monograph. It is brought thoroughly up to date, and deals adequately with the whole subject."—*English Mechanic.*

" The book is interesting and reflects the world-wide interest in potash which developed during the war."—*American Fertiliser.*

" A most valuable book on the subject of potash. Each chapter is a discriminating discussion of its subject. A valuable feature of the book is the reference list at the end, which comprises 179 titles."—*Economic Geology.*

" Essentially a reference work, Mr. Johnstone's book is yet of more than passing interest to the general reader."—*Pioneer.*

" The most useful summary that has been produced since that written by Messrs. H. S. Gale and W. B. Hicks for the Geological Survey of the United States."—*Nature.*

" Les sujets traités dans cet ouvrage, étant d'une importance capitale pour l'Agriculture et pour diverses industries ne peuvent qu'intéresser un grand nombre de lecteurs."—*Chimie et Industrie.*

Zinc Ores

" This is an admirably compiled monograph on zinc ores, with special reference to the British Empire. It is one of a series on mineral resources, and shows that the committee of the Imperial Institute on these products is doing most useful and interesting work."—*British Trade Journal.*

" The pamphlet is an admirable compilation, doing credit to the staff of the Mineral Investigation Department of the Institute, and it should be in the hands of all interested in zinc ores and their products."—*Glasgow Times.*

" Congratulations are due to the staff of the Imperial Institute, for the excellent pamphlet on Zinc Ores just published."—*Mining Magazine.*

Manganese Ores and Tin Ores

" This is an Imperial Institute publication which reflects credit on the author, who has prepared an interesting and useful monograph, as a result of an exhaustive study of all published information on the subject."—*Geological Magazine.*

" To the chemist or the engineer interested in metallurgy or mining, who hitherto has had to refer to the monographs published by the United States Geological Survey, these books will come as a boon ; they embody a mass of information worth far more than the published price."—*Asiatic Review.*

" The Imperial Institute is doing excellent service in issuing the handy monographs on the mineral resources of the British Empire, two of which have recently appeared. In both cases the work has been carefully and thoroughly done, and the handbook may be looked upon as giving trustworthy information upon the subjects treated in a compact and convenient form."—*Nature.*

" As a whole, the monograph is a complete treatise on the occurrence and production of tin ore as far as it is possible to make it in a few pages, and it is the best résumé of the subject yet published, the brief geological accounts being particularly good."—*Geological Magazine.*

Tungsten Ores

" It should be found on the book-shelves of all interested, however remotely, in tungsten and its ores. The printing and make-up are both admirable, and the large scale of the diagrams showing production in various

countries makes these specially instructive." —*Mining Magazine.*

"This monograph or pamphlet is exceedingly well and carefully written. It is a valuable compendium of the geographic and geologic occurrences of tungsten, its uses and its extraction."—*Engineering and Mining Journal.*

"One of the special monographs on mineral resources. These monographs are of great value because they co-ordinate and gather a vast amount of information contained in numerous other publications, and also embody the results of the investigations undertaken at the Imperial Institute."—*United Empire.*

Coal

"We can commend this publication as a useful summary of the coal resources of the world so far as the British Empire is concerned, a limitation which enables our Imperial coal resources to be more fully dealt with than would have been otherwise possible."—*Colliery Guardian.*

"It can fairly claim to present in a convenient form a sketch of the coal-fields of the British Empire and to act as an index to the vast mass of scattered publications on the subject."—*Mining Magazine.*

Platinum Metals

"Chapter II deals with the sources of supply of the platinum metals from the British Empire, contains in condensed form descriptions of occurrences throughout the Empire. It is very complete and useful."—*Mining Magazine.*

"Those interested will find a great deal of valuable information in this little handbook on the occurrences, characters, and uses of the platinum group, as well as particulars of production, and distribution in the world's markets."—*Industrial Australian and Mining Standard.*

"This publication forms one of the useful series of monographs on metals issued by the Mineral Resources Committee of the Imperial Institute. It comprises a full account of the world's resources so far as known of the metals platinum, palladium, iridium, osmium, ruthenium and rhodium."—*Geological Magazine.*

Lead Ores

"The monograph has been prepared in the light of the best available information from all sources, collected and arranged by the special staff of the Imperial Institute, and

should, therefore, prove informative even to men experienced in the handling and working of lead ores, but whose information on a variety of points may not be quite up to date. To those less acquainted with the subject, it cannot fail to be instructive."—*Industrial Australian and Mining Standard.*

"The monograph on lead gives a valuable summary and bibliography of the chief lead deposits of the Empire and shorter references to those of other countries."—*Nature.*

"The information given is clear, up-to-date and concisely expressed, while the views stated on the origin of lead ores, in many cases a subject of controversy, are fair and temperate."—*Geological Magazine.*

Chromium Ore

"The information given regarding the utilising of chromium is useful. Useful information is given in Chapter II, which describes the principal deposits of chromium ore of the British Empire, and in Chapter III, which deals with foreign sources of supply."—*Mining Magazine.*

"This monograph contains a very complete account of the geological occurrences and exploitation of chromite, the only practical ore of the metal, together with a summary of its technical treatment and uses."—*Geological Magazine.*

Petroleum

"It compresses into 110 pages a considerable amount of information regarding petroleum in the various countries of the world, besides a bibliography and a full-page map."—*Oil News.*

"The Imperial Institute has done good service in the preparation of its series of monographs on mineral resources. The volume, though small, is packed with information, and should be useful by reason of its authoritative nature."—*Geographical Journal.*

"Much valuable information will be found in the monograph."—*British Dominions Year Book,* 1922.

"This admirably written, valuable and compact monograph."—*Lloyd's List.*

"It should prove a valuable book of reference for all who are interested in the petroleum industry."—*Mining World.*

"It contains an extremely concise and useful chapter

on the characteristics, occurrences, mining, refining and uses of petroleum. The rest of the book describes the sources of supply of petroleum, and is very comprehensive in its information."—*Chemical, Engineering and Mining Review.*

"It is particularly gratifying to find that one of the few British publications on petroleum treats of the subject in a manner which leaves very little to be desired."—*Mining Magazine.*

Silver Ores

"Mr. Cronshaw's volume is necessarily of a technical nature, but its contents are all the more valuable on that account, and the many tables of statistics should be of considerable use for reference."—*Lloyd's List.*

"A masterly treatise upon the world's silver-producing centres. The monograph, in a word, is very complete on the silver question, and will deservedly be popular amongst miners and metallurgists."—*Mining World.*

"It consists largely of a résumé of the available information on the subject and will be found invaluable as a book of reference."—*Mining and Scientific Press.*

Oil Shales

"A valuable monograph."—*Statist.*

"A most useful résumé of oil shales affairs throughout the world. We doubt if, for instance, all the information concerning oil shale in England, Scotland and Ireland has ever appeared together in one volume before. As a concise guide to the world's oil shale fields it is admirable." —*Petroleum World.*

"A concise account of the oil shale deposits throughout the world."—*Spectator.*

"We welcome Dr. Cronshaw's latest work not so much as a contribution to oil-shale literature, but rather as a significant indication of the far-reaching developments to be expected when these deposits become better known and more closely investigated."—*Mining Magazine.*

"A welcome and useful addition to the series of Imperial Institute monographs. A general account of the occurrence of oil shales throughout the world is condensed from the literature in a minimum of space."—*Chemical and Metallurgical Engineering.*

"Valuable as a record of attempts to locate such shales by boring in England."—*Nature.*

Molybdenum Ores

"Dr. Rastall's work may be regarded as an essential item in the library of an iron and steel manufacturer."—*Journal of the Royal Society of Arts.*

"Dr. Rastall has performed his task with great ability and has put together a considerable amount of information which has been collected from scattered sources. A comprehensive summary of great clearness. The bibliography is most useful."—*Mining Magazine.*

"This publication supplies in a collected form most of the information available in regard to this mineral."—*Mining Journal.*

"May we have two copies of your report on Molybdenum, please? The copy you so generously sent has been in such constant use that it is quite worn already, and the demand for a second copy makes it very desirable that we have two new copies.

"If you can comply with this request we will be very grateful."—*Department of Mines, Canada.*

Copper Ores

"A very welcome book, and gives in a concise form particulars regarding deposits in every part of the world. It has many excellent charts and tables, and is supplemented by a world map of copper deposits. It should be of very great interest to all connected with the metal trades, as well as others who use, even to a small extent, copper in their manufacture."—*Raw Materials Review.*

"A comprehensive and well-proportioned survey of what is known about the distribution of copper ores."—*Scotsman.*

"A digested survey of the world's copper ore resources, having also a special chapter on the occurrence and character of the ores, refinery methods, and the uses of the finished metal."—*British Trade Review.*

Mercury Ores

"The pamphlet enters very fully into the sources of supply of mercury ores, which have been discovered in various parts of the Empire. There are also copious notes on discoveries which have been made in foreign countries."—*Mining World.*

"Mr. Halse deals very elaborately with the subject of mercury ores and covers an extensive ground."—*Indian Engineering.*

"This important work . . . will be found extremely useful. The work contains a general survey of the occurrences and commercial utilisation of the more important minerals."—*Financier.*

Map and Diagrams of Metal Resources (Second Edition)

"A publication invaluable both for reference and educational purposes is 'The Imperial Institute Map of the Chief Sources of Metals of the British Empire.' The map is certainly the handiest and most up-to-date publication of its kind which has appeared of late years."—*African World.*

"To those interested in mining and metallurgy this map, which has been most carefully and artistically drawn, will prove a very valuable addition to the usual works of reference."—*Financial News.*

"The map and diagrams should prove of much value, particularly in the teaching of commercial geography."—*Times Trade Supplement.*

"The map gives at a glance a large amount of useful information on the subject."—*Engineering.*

"It is executed on a bold scale with a view to its utilisation as a wall-map for reference and educational purposes."—*Nature.*

"C'est un instrument précieuse, pour l'enseignement de la géographie commerciale."—*La Géographie.*

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

The following summaries have been prepared from a selection of the Reports made by the Director of the Imperial Institute to the Dominion, Colonial and Indian Governments.

INVESTIGATIONS OF THE QUALITY OF PLANTATION RUBBER CONDUCTED UNDER THE CEYLON RUBBER RESEARCH SCHEME. PART V.

THE present article is in continuation of previous Reports published in this BULLETIN (1916, **14**, 495; 1918, **16**, 409; 1920, **18**, 1; 1922, **20**, 431), dealing with the results of mechanical and vulcanisation tests and the chemical examination of rubber prepared in connection with the Ceylon Rubber Research Scheme. The following account deals with the remainder of the samples prepared in Ceylon and gives a summary of the principal conclusions to be drawn from the whole of the work.

SERIES X

Sections 1 to 5

The thirty-three samples of rubber included in Sections 1 to 5 of Series X were prepared in Ceylon in order to study the effect of allowing the coagulum to mature for different periods before crêpeing, and in most of the samples alkaline creosote solution was added to the latex before coagulation.

The estate on which the samples were prepared is not named, nor is it stated whether the coagulum was allowed to mature in or out of the serum. In a previous set of samples (Series VIII, Section 2, this BULLETIN, 1922, 20, 444) the coagulum was matured in the serum and it is presumed that the same procedure was adopted in these experiments.

The following are the details relating to the preparation of these samples and the results of their examination :

Section 1.—Effect of allowing the Coagulum to mature for Varying Periods before Crêpeing. No Creosote added to Latex

Results of Examination

No.		Time of vulcanisation. *Mins.*	Tensile strength. *lb. per sq in*	Elongation. *Per cent.*	Permanent set. *Per cent.*
438	Control sheet . . .	70	2,310	884	2·6
439	Crêped day after coagulation	103	2,430	890	2·1
440	Crêped three days after coagulation . . .	73	2,450	886	2·1
441	Crêped five days after coagulation	60	2,440	882	2·5
442	Crêped seven days after coagulation . . .	63	2,390	880	2·7
443	Crêped nine days after coagulation	55	2,490	898	2·7
444	Crêped eleven days after coagulation . . .	53	2,400	898	2·3

Remarks

The samples in this section represent the coagulum crêped at varying intervals of time after coagulation, no creosote having been added to the latex.

Samples No. 438 (the control sheet) and 439 (crêped the day after coagulation) show the usual difference between crêpe and sheet as regards time of cure, but in this instance the crêpe has a better tensile strength than the control sheet, which is not usually the case.

A comparison of the results obtained with the crêped samples Nos. 439–44 shows that by allowing the coagulum to mature for varying periods before crêpeing the time of cure is progressively decreased the longer the coagulum is left, the quickest time of cure being that of the crêpe

made 11 days after coagulation. The latter sample cured much more quickly than the control sheet, viz. 53 minutes as against 70 minutes.

By allowing the coagulum to mature before crêpeing the mechanical properties appear to have been improved. The figures are approximately the same for all the samples of crêpe and are somewhat higher than those given by the control sheet.

Section 2.—Effect of allowing the Coagulum to mature for Varying Periods before Crêpeing. Creosote added to Latex

Results of Examination

No.		Time of vulcanisation. *Mins.*	Tensile strength. *lb. per sq. in.*	Elongation. *Per cent.*	Permanent set. *Per cent.*
445	Control sheet . . .	70	2,340	881	3·3
446	Crêped day after coagulation	85	2,470	895	2·0
447	Crêped three days after coagulation . . .	72	2,410	883	2·4
448	Crêped five days after coagulation	52	2,440	898	2·2
449	Crêped seven days after coagulation . . .	65	2,390	891	2·3
450	Crêped nine days after coagulation	66	2,410	860	2·9

Remarks

This section is a repetition of Section 1, but in this case creosote was added to the latex before coagulation.

The results are similar to those in Section 1. The maturing of the coagulum leads to a reduction in the time required for vulcanisation, and the matured crêpes are again stronger than the control sheet.

The most remarkable feature of the results is that the crêpe (No. 446) prepared the day after the coagulation of the latex should cure in so short a time as 85 minutes. This is only 15 minutes longer than the control sheet.

Instead of a steady decrease in the vulcanisation time as the period of maturing increases, it will be seen that the vulcanisation time is at a minimum 5 days after coagulation, and then increases in the case of the samples matured for 7 and 9 days.

Section 3.—Effect of allowing Coagulum to mature for Varying Periods before Crêpeing (Creosote being added to Latex) and also of blocking the Wet Crêpe

Results of Examination

No.		Time of vulcanisation. *Mins.*	Tensile strength. *lb. per sq. in.*	Elongation. *Per cent.*	Permanent set. *Per cent.*
451	Control sheet . . .	83	2,320	880	2·3
452	Crêped day after coagulation	112	2,380	878	2·2
453	Crêped three days after coagulation . . .	100	2,350	884	2·6
454	Crêped five days after coagulation	73	2,430	895	2·0
455	Crêped seven days after coagulation . . .	65	2,470	887	1·3
456	Crêped nine days after coagulation	58	2,450	904	2·6
457	Crêped eleven days after coagulation . . .	61	2,450	884	3·0
458	Portion of No. 452 blocked immediately after crêpeing	67	2,440	877	2·7
459	Portion of No. 452 blocked one day after crêpeing .	65	2,440	891	2·6

Remarks

The crêpe No. 452 prepared on the day after coagulation of the latex shows the usual longer time of cure as compared with the control sheet, but no difference in mechanical properties.

Allowing the coagulum to mature for 3 days before crêpeing has not lessened the time of cure sharply as it did in Sections 1 and 2, and the time of cure remains high. Longer maturing of the coagulum before crêpeing greatly reduces the time of cure, but not quite to such an extent as in the previous sections.

The mechanical properties of the matured crêpe, especially after five days' maturation and longer, are superior to those of the control sheet.

In Experiment 458 a portion of the coagulum was converted into crêpe the day after coagulation and was blocked immediately afterwards. In Experiment 459 another portion of the same crêpe was blocked one day after crêpeing. The two samples have practically the same rate of cure and the same mechanical properties. The mechanical properties are better than those of the

crêpe from which they were made (No. 452) and the time of vulcanisation is much less, being even less than that of the control sheet. These results indicate that if crêpe made in the usual way is blocked on the day after coagulation without drying, a rubber is obtained which will cure more quickly and have better mechanical properties than if converted into sheet. In previous experiments, Series I and II, Section 16, it was also found that blocking wet crêpe greatly reduced the time of cure and improved the tensile strength (cf. this BULLETIN, 1916, **14**, 555).

Section 4.—Effect of preparing Rubber in Wet Blocks (from Sheet and Crêpe) and in Thin and Thick Slab (Creosote being added to Latex)

Results of Examination

No.		Time of vulcanisation. *Mins.*	Tensile strength. *lb per sq. in.*	Elongation *Per cent.*	Permanent set *Per cent.*
460	Control sheet	69	2,420	890	3·1
461	Sheet	77	2,310	874	3·0
462	Sheet, blocked whilst wet .	55	2,600	893	2·5
463	Coagulated in thin layers. Not machined. (Thin slab)	75	2,300	870	3·0
464	Coagulated in thick layers Not machined. (Thick slab)	53	2,500	892	2·3
465	Crêped	110	2,310	884	3·0
466	Crêped and blocked immediately	73	2,430	876	2·4

Remarks

In the preparation of the samples in this section creosote was added to the latex and the coagulum was converted into sheet, slab and crêpe.

Comparing the samples of sheet Nos. 460 and 461, the addition of creosote is seen to have increased somewhat the time of cure and to have slightly lowered the tensile strength.

In Experiment 462 the sheet was blocked whilst wet, and the resulting rubber has a shorter time of cure and better mechanical properties than the control sheet.

Sample No. 463 was a thin slab, and had practically the same time of cure and mechanical properties as sheet No. 461, creosote being present in both cases.

Sample No. 464 (thick slab) shows, however, a decided difference from the previous samples. The time of cure is shortened and the mechanical properties improved,

the tensile strength being almost as high as that of the wet blocked sheet.

Sample No. 465 consisted of crêpe made in the usual fashion. The time of cure is as usual high, twice that of the thick slab, and the tensile strength somewhat lower.

In sample No. 466 the effect of blocking the crêpe (without drying) has been to give a low time of cure, below that of sheet No. 461, and the mechanical properties are distinctly superior to those of the latter sample. This is a confirmation of the results obtained in Section 3 with regard to the effect of blocking wet crêpe.

Section 5.—Effect of allowing Coagulum to mature for Varying Periods before Crêpeing. No Creosote added to Latex

Results of Examination

No.		Time of vulcanisation. *Mins.*	Tensile strength. *lb. per sq. in.*	Elongation. *Per cent.*	Permanent set. *Per cent.*
467	Control sheet	75	2,280	879	3·3
468	Coagulum crêped after two days	112	2,620	894	2·5
469	Coagulum crêped after four days	100	2,520	878	2·7
470	Coagulum crêped after eight days	88	2,500	887	2·6

Remarks

In this section the coagulum was crêped after maturing for 2, 4 and 8 days. The crêpe made after 2 days cures in about the average time for crêpe rubber; that made after 4 days cures somewhat more quickly; and that after 8 days more quickly still, but the time of cure even of the rubber crêped after 8 days is longer than for the control sheet. The tensile strength of the vulcanised rubber in all three samples of crêpe is unusually high and well above that of the control sheet.

General Remarks on Sections 1–5

The curves given in Fig. 1 show the time the coagulum was allowed to mature before crêpeing plotted against the time of cure of the crêpe. They show that the maturing of the coagulum is a very irregular process, and that, as judged by the rate of cure, it may proceed quickly or slowly. Each of the four curves, however, shows the same general tendency for the vulcanisation time to decrease as the period of maturing is increased; but it is

significant that in the samples crêped the day after coagulation the vulcanisation times vary from 85 to 112 minutes, and in those crêped after maturing for 8 days the vulcanisation times vary from 59 to 88 minutes. The variation, instead of decreasing, has increased.

On the other hand, samples of crêpe blocked while wet have a very constant time of cure and very good mechanical properties. Altogether six samples of wet block crêpe have been prepared on four different occasions,

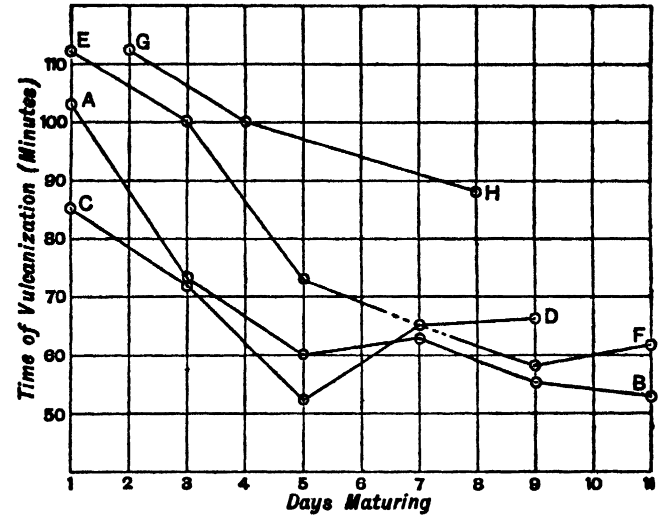


FIG. 1.—Relation between time of maturation of coagulum and time of vulcanisation of crêpe rubber.

Curve AB represents results given by samples in Series X, Section 1.
,, CD ,, ,, ,, ,, ,, X, ,, 2.
,, EF ,, ,, ,, ,, ,, X, ,, 3.
,, GH ,, ,, ,, ,, ,, X, ,, 5.
Curves AB and GH are for non-creosoted rubbers.
,, CD ,, EF are for creosoted rubbers.

and the maximum variation in vulcanisation time has been 65 to 73 minutes, while the tensile strength has always fallen between 2,420 lb. and 2,510 lb. per sq. in.

The good tensile strength obtained in this series of experiments with crêpe from matured coagulum is not in accordance with the results obtained with previous samples prepared at Gikiyanakande (Series IX, Section 2, this BULLETIN, 1922, **20**, 447), where the highest tensile strength out of eight samples was 2,250 lb. per sq. in., and the lowest 2,110 lb. per sq. in., and where it was significant that the coagulum which had matured the longest gave the weakest rubber.

The general conclusion from these experiments is that crêpe prepared from matured coagulum cures more rapidly than ordinary crêpe, but that the results are irregular, both as regards time of cure and tensile strength.

Series X

Sections 6 to 11

The twenty-five samples of rubber included in Sections 6 to 11 of Series X were prepared in order to determine the effect of adding increasing amounts of caustic soda solution to the latex before coagulating with acetic acid. It is presumed that, as in previous cases in which alkaline creosote solution was added to the latex, an increased amount of acetic acid was used in coagulating to compensate for the caustic soda present.

The following are the details relating to the preparation of these samples and the results of their examination:

Section 6.—Effect of adding Caustic Soda to the Latex and allowing the Coagulum to mature for five days before Crêpeing

Results of Examination

No.		Time of vulcanisation *Mins*	Tensile strength. *lb per sq in.*	Elongation *Per cent*	Permanent set. *Per cent.*
471	Control sheet . . .	80	2,380	884	2·6
472	Crêpe. 200 c c. of 10 per cent. caustic soda solution added to 2 litres of latex . .	68	2,180	859	4·0
473	Crêpe. 400 c c. of 10 per cent. caustic soda solution added to 2 litres of latex . .	56	1,980	855	Broke

Section 7.—Effect of adding Caustic Soda to the Latex and converting into Crêpe

Results of Examination

No.		Time of vulcanisation. *Mins.*	Tensile strength. *lb per sq in.*	Elongation. *Per cent.*	Permanent set. *Per cent.*
474	Control sheet . . .	86	2,410	870	2·5
475	Crêpe. 25 c c. of 10 per cent. caustic soda solution added to 2 litres of latex . .	113	2,510	870	2·9
476	Crêpe. 50 c.c. of 10 per cent. caustic soda solution added to 2 litres of latex . .	140	2,200	871	2·6
477	Crêpe. 100 c.c. of 10 per cent. caustic soda solution added to 2 litres of latex . .	75	2,340	878	2·3

Section 8.—Effect of adding Caustic Soda to the Latex and converting into Crêpe

Results of Examination

No.		Time of vulcanisation. *Mins.*	Tensile strength. *lb. per sq. in.*	Elongation. *Per cent.*	Permanent set. *Per cent.*
478	Control sheet . . .	80	2,470	875	2·8
479	Crêpe. 25 c.c. of 10 per cent. caustic soda solution added to 2 litres of latex . .	80	2,500	881	2·3
480	Crêpe. 50 c.c. of 10 per cent. caustic soda solution added to 2 litres of latex . .	83	2,490	880	2·0
481	Crêpe. 100 c.c. of 10 per cent. caustic soda solution added to 2 litres of latex . .	90	2,310	880	3·1

Section 9.—Effect of adding Caustic Soda to the Latex and allowing the Coagulum to mature for Two Days before Crêpeing

Results of Examination

No.		Time of vulcanisation. *Mins.*	Tensile strength. *lb. per sq. in.*	Elongation *Per cent.*	Permanent set. *Per cent.*
482	Control sheet . . .	78	2,480	885	1·9
483	Crêpe. 50 c.c. of 10 per cent. caustic soda solution added to 2 litres of latex. Crêped 2 days after adding acetic acid	120	2,310	877	1·9
484	Crêpe. 75 c.c. of 10 per cent. caustic soda solution added to 2 litres of latex. Crêped two days after adding acetic acid	100	2,140	852	2·6
485	Crêpe. 100 c c. of 10 per cent. caustic soda solution added to 2 litres of latex. Crêped two days after adding acetic acid	77	2,380	885	2·6

Section 10.—Effect of adding Caustic Soda to Latex and allowing Coagulum to mature One Day before Crêpeing

Results of Examination

No.		Time of vulcanisation. *Mins.*	Tensile strength. *lb. per sq. in.*	Elongation. *Per cent.*	Permanent set. *Per cent.*
486	Control. Medium brown sheet	78	2,460	866	2·3
487	Crêpe. 50 c.c. of 10 per cent. caustic soda solution added to 2 litres of latex. Crêped one day after coagulation .	85	1,990	843	3·0
488	Crêpe. 100 c.c. of 10 per cent. caustic soda solution added to 2 litres of latex. Crêped one day after coagulation .	108	2,220	873	2·6
489	Crêpe. 200 c.c. of 10 per cent. caustic soda solution added to 2 litres of latex. Crêped one day after coagulation .	80	2,040	864	2·4

Section 11.—Effect of adding Caustic Soda Solution to the Latex and allowing Coagulum to mature Two Days before Crêpeing

Results of Examination

No.		Time of vulcanisation. *Mins.*	Tensile strength. *lb. per sq. in.*	Elongation. *Per cent.*	Permanent set. *Per cent.*
490	Control. Medium brown sheet. Discoloured with darker patches and with mould	80	2,420	880	2·4
491	Crêpe. 50 c c. of 10 per cent. caustic soda solution added to 2 litres of latex. Coagulum crêped two days after the addition of acetic acid	58	2,430	888	3·1
492	Crêpe. 100 c c. of 10 per cent. caustic soda solution added to 2 litres of latex. Coagulum crêped two days after the addition of acetic acid	91	2,340	875	2·7
493	Crêpe. 200 c c. of 10 per cent. caustic soda solution added to 2 litres of latex. Coagulum crêped two days after the addition of acetic acid	108	1,820	817	3·8

Along with the above samples, there were also sent for examination two single samples :

No. 494.—Latex treated with caustic soda solution, dialysed and coagulated with acetic acid. There was not sufficient of this sample for testing.

No. 495.—Creosoted roll. This sample had the following physical properties : Vulcanised in 50 minutes ; tensile strength, 2,500 lb. per sq. in. ; elongation at break, 884 per cent. ; and permanent set, 1·7 per cent.

Remarks on Sections 6 to 11

The outstanding feature of these results is their lack of consistency. For example, samples 476 and 480 were prepared in the same way, the same amount of caustic soda was added to the latex, and in neither case was the coagulum matured, yet the former requires 140 minutes for vulcanisation, while the latter requires 83 minutes.

Unfortunately, in addition to variable amounts of caustic soda being added, another complicating factor has been introduced. Some of the samples were allowed to mature in the serum for 1 day, some for 2 days, and some

for 5 days. Only those samples which have been matured for the same period of time and in the preparation of which the same amount of caustic soda has been used, are comparable. The results, like those obtained for the unmatured samples, are inconsistent. The same conditions sometimes give rise to a very slow-curing rubber, and sometimes to a fast-curing rubber. For instance, samples 483 and 491 were both matured 2 days before crêpeing, and in both cases the same amount of caustic soda was added to the latex, yet the former requires 120 minutes for vulcanisation, while the latter only requires 58 minutes.

It was found that the vulcanisation results could be correlated with the percentage of " ash " from the rubber. The higher the amount of " ash," the more quickly does the rubber vulcanise. Hence it may be concluded that the large variations in the time of vulcanisation of rubber prepared by adding caustic soda to the latex are due to the variable retention of varying amounts of sodium compounds in the rubber. The rubbers furnishing a low percentage of " ash," and from which, therefore, the sodium compounds have been almost completely washed out, have an exceptionally long time of cure.

It is difficult to wash out completely the sodium compounds from rubber, and, as they are strong accelerators of vulcanisation, they are responsible for large variations in time of cure according to the amount left in the rubber after washing.

The results show that the addition to latex of caustic soda in the proportions used in these experiments gives rise to rubber varying widely in vulcanising properties. Moreover nearly all the samples dealt with in this report were inclined to be " tacky." It is clear that this method of preparation should not be adopted, especially as the use of caustic soda is stated to affect adversely the keeping properties of the vulcanised rubber.

SERIES XI

Sections 1 to 4

These rubbers were all prepared on the Gikiyanakande Estate, those in Sections 1 and 3 being prepared from the

young trees used for Series I experiments; and the samples in Sections 2 and 4 from the older trees used for Series II experiments (cf. this BULLETIN, 1916, 14, 498). The object of the experiments was to determine whether the chemical composition of the latex could be correlated with the composition and mechanical properties of the crêpe and sheet rubbers prepared therefrom. It was stated that the analyses of the latex in Ceylon were carried out "under extraordinarily difficult conditions, for there is no laboratory on the estate on which these trees are growing, which contains apparatus and equipment necessary for analytical work of this nature. The initial steps of the analyses were carried out on the estate and the processes completed in the laboratory of the Government analyst in Colombo—forty miles away."

The results of the analyses of the latex and serum were given as follows:

Latex No.		Latex.			Serum.	
		Total solids.	Dry rubber.	Nitrogen.	Total solids.	Nitrogen.
		Per cent.	*Per cent.*	*Per cent*	*Per cent*	*Per cent.*
From trees used for the Series I experiments	1	38·4	34·0	0·17	1·8	0·07
	2	33·0	30·0	0·20	1·5	0·05
	3	38·5	34·0	0·26	1·9	0·04
	4	47·1	41·0	0·16	2·2	0·06
	5	43·6	38·0	0·20	2·7	0·04
	6	44·4	38·0	0·23	2·1	0·06
From trees used for the Series II experiments	7	40·5	36·1	0·17	1·9	0·07
	8	39·6	36·0	0·17	2·0	0·07
	9	43·0	39·0	0·23	1·7	0·05
	10	34·0	30·7	0·21	1·9	0·04
	11	45·4	41·0	0·19	2·3	0·04
	12	33·2	29·5	0·20	1·5	0·02

The rubbers prepared from these samples of latex were tested at the Imperial Institute with the following results:

No.		Time of vulcanisation.	Tensile strength.	Elongation.	Permanent set.
		Mins.	*lb. per sq in.*	*Per cent*	*Per cent.*
	Section 1				
496	Sheet from Latex No. 1	60	2,480	888	3·1
497	" " " 2	60	2,350	893	3·2
498	" " " 3	55	2,270	884	3·4
499	" " " 4	48	2,360	889	2·8
500	" " " 5	60	2,230	888	3·0
501	" " " 6	64	2,440	893	2·9

		Time of vulcanisation. *Mins.*	Tensile strength. *lb. per sq. in.*	Elonga-tion. *Per cent.*	Permanent set. *Per cent.*
	Section 2				
502	Sheet from Latex No 7 .	75	2,430	883	3 1
503	,, ,, ,, 8 .	70	2,350	881	2·7
504	,, ,, ,, 9 .	64	2,430	899	2·9
505	,, ,, ,, 10 .	64	2,390	883	2·9
506	,, ,, ,, 11 .	78	2,420	888	3·0
507	,, ,, ,, 12 .	75	2,300	873	2·9
	Section 3				
508	Crêpe from Latex No. 1 .	95	2,410	883	3·0
509	,, ,, ,, 2 .	103	2,270	889	3·2
510	,, ,, ,, 3 .	106	2,380	886	2·6
511	,, ,, ,, 4 .	110	2,270	884	2·8
512	,, ,, ,, 5 .	95	2,370	890	2·7
513	,, ,, ,, 6 .	108	2,240	882	2·8
	Section 4				
514	Crêpe from Latex No. 7 .	108	2,390	885	2·7
515	,, ,, ,, 8 .	126	2,090	876	3·3
516	,, ,, ,, 9 .	125	2,260	888	3·1
517	,, ,, ,, 10 .	120	2,210	886	3·0
518	,, ,, ,, 11 .	125	2,210	886	2·7
519	,, ,, ,, 12 .	125	2,220	884	3·0

The samples were chemically analysed at the Imperial Institute after washing and drying, with the following results :

No.		Ash. *Per cent.*	Resin. *Per cent*	Protein. *Per cent*	Caoutchouc. *Per cent*
	Section 1				
496	Sheet from Latex No. 1 .	0·30	2·21	2·38	95·11
497	,, ,, ,, 2 .	0·26	1·95	2·41	95·38
498	,, ,, ,, 3 .	0·33	1·72	2·19	95·76
499	,, ,, ,, 4 .	0·30	2·33	2·12	95·25
500	,, ,, ,, 5 .	0·29	1·92	2·33	95·46
501	,, ,, ,, 6 .	0·22	1·77	2·17	95·84
	Section 2				
502	Sheet from Latex No. 7 .	0·25	1·82	2·05	95·87
503	,, ,, ,, 8 .	0·25	1·67	2·11	95·97
504	,, ,, ,, 9 .	0·27	1·66	1·98	96·09
505	,, ,, ,, 10 .	0·31	1·84	2·02	95·83
506	,, ,, ,, 11 .	0·26	1·72	2·13	95·89
507	,, ,, ,, 12 .	0·35	1·67	2·25	95·75
	Section 3				
508	Crêpe from Latex No. 1 .	0·32	3·00	2·34	94·34
509	,, ,, ,, 2 .	0·26	3·02	2·35	94·37
510	,, ,, ,, 3 .	0·27	2·77	2·14	94·82
511	,, ,, ,, 4 .	0·27	2·90	2·14	94·82
512	,, ,, ,, 5 .	0·24	2·77	2·29	94·70
513	,, ,, ,, 6 .	0·29	2·69	2·27	94·75

		Ash. Per cent.	Resin. Per cent.	Protein. Per cent.	Caoutchouc. Per cent.
	Section 4				
514	Crêpe from Latex No 7 .	0·27	2·74	2·31	94·68
515	,, ,, ,, 8 .	0·29	2·56	1·94	95·21
516	,, ,, ,, 9 .	0·25	2·69	2·00	95·06
517	,, ,, ,, 10 .	0·22	2·78	2·19	94·81
518	,, ,, ,, 11 .	0·21	2·59	2·09	95·11
519	,, ,, ,, 12 .	0·27	2·56	2·12	95·05

Remarks

The results of the mechanical and chemical tests at the Imperial Institute are summarised below for each section :

Mechanical Tests

Section.	Group of trees	Form of rubber.	Vulcanisation time.	Tensile strength lb per sq in	Elongation at break. Per cent	Permanent set Per cent
1	Series I trees .	Sheet .	58 ±4	2,360 ±60	889 ±3	3·1 ±0·2
3	Series I trees .	Crêpe .	103 ±5	2,320 ±60	886 ±3	2·9 ±0·2
2	Series II trees.	Sheet .	72 ±4	2,390 ±40	885 ±3	2·9 ±0·2
4	Series II trees.	Crêpe .	122 ±5	2,230 ±60	884 ±3	3·0 ±0·2

It will be noted that the sheet and crêpe rubbers from Series II trees (the older trees) take distinctly longer to vulcanise than the sheet and crêpe from Series I trees. The average time of vulcanisation of sheet rubber from Series II trees taken over an extended period has been found to be 73 minutes, and from Series I trees 66 minutes. These new results confirm the conclusion previously arrived at that even when a standard method of preparation is used, different groups of trees will yield rubbers curing at different rates. It also seems probable that a set of trees which furnish slow-curing sheet will also give slow-curing crêpe, and when a group of trees produce quick-curing sheet, they will also give quick-curing crêpe. It is of interest to note that the difference in the times of cure of the two sets of sheet rubbers is 14 minutes, or 24 per cent., while the difference in the times of cure of the two sets of crêpe rubbers is 19 minutes, or 18 per cent. The variation in time of cure of crêpe rubber is therefore less than that of sheet.

So far only the variations found in rubbers prepared from different groups of trees have been considered. When the results obtained for rubbers prepared from the same group of trees, but on different occasions, are examined,

the above conclusions are only partly correct. The summarised results of the mechanical tests show that the average variations in time of vulcanisation of the crêpe rubbers is ± 5 minutes, and of the sheet rubbers ± 4 minutes. For example, if all the sheet rubbers in Section 1 had been cured for 58 minutes, the average error in cure would have been 4 minutes, or 7 per cent.; whereas if all the crêpe rubbers in Section 3 had been cured for 103 minutes, the average error would have been 5 minutes, or 5 per cent. It may therefore be concluded that there is

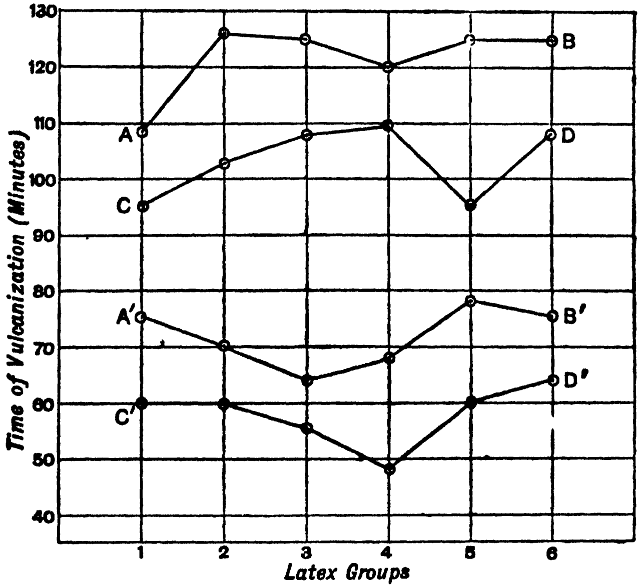


FIG. 2.—Time of vulcanisation of sheet and crêpe rubbers from the same latex.

Curve A B	represents	crêpe	rubber from Series	II trees..
„ A'B'	„	sheet	„ „ „	II „
„ C D	„	crêpe	„ „ „	I „
„ C'D'	„	sheet	„ „ „	I „

less variation in the time of cure of crêpe rubbers prepared from the same group of trees on different occasions than there is in the corresponding sheet. The results, however, do not indicate that latex obtained from one group of trees on different occasions will give rise to slow- or fast-curing crêpe rubbers corresponding with slow- or fast-curing sheet rubbers. This point is brought out very clearly in the accompanying graph (Fig. 2). The times of vulcanisation are shown for sheet and crêpe from each group of latex. The sheet and crêpe rubbers from

Series II trees take longer to cure than the sheet and crêpe from Series I trees, but there is no relation between the variation in time of vulcanisation of sheet and crêpe from the same group of trees.

It is of interest to compare the amounts of protein in the latex with the amounts present in the dry rubber. The figures are given in the following table, the percentages being expressed in each case on the dry rubber:

Latex groups	1	2	3	4	5	6	Average.
Series I trees							
Protein in latex .	3·1	4·2	4·8	2·4	3·3	3·8	3·6 ±0·7
Protein in dry sheet rubber .	2·38	2·41	2·19	2·12	2·33	2·17	2·27 ±0·09
Protein in dry crêpe rubber .	2·34	2·35	2·14	2·14	2·29	2·27	2·26 ±0·06
Series II trees							
Protein in latex .	2·9	2·9	3·7	4·3	2·7	4·3	3·5 ±0·6
Protein in dry sheet rubber .	2·05	2·11	1·98	2·02	2·13	2·25	2·09 ±0·07
Protein in dry crêpe rubber .	2·31	1·94	2·00	2·19	2·09	2·12	2·11 ±0·11

It will be seen from the results of the analysis of the samples of latex and serum (p. 302) that on coagulating the rubber the coagulum contains the bulk of the nitrogen. The above results show that the dry rubber usually contains much less protein than was originally present in the latex. There is therefore a considerable loss of protein in converting the coagulum into dry rubber.

The relation between the amounts of protein in the latex and in the dry rubber is shown graphically in Fig. 3. One of the two sets of curves represents the latex and rubber from the young trees used in Series I experiments, and the other the latex and rubber from the older trees used in Series II experiments. In every case the protein is expressed as a percentage of the dry rubber. The graphs show clearly the wide variations in the amounts of protein in the latex; the very much smaller variation in the protein in the dry washed rubber; and the remarkable differences between the quantity of protein in the latex and that retained in the dry washed rubber.

The amounts of protein in corresponding samples of sheet and crêpe are in many cases almost identical, which indicates that differences in the mechanical treatment of

the coagulum and time of drying have little influence on the amount of protein in the rubber.

It is known that rubber may lose nitrogen compounds in three ways:

(1) First by the squeezing out of serum from the coagulum. This only results in a small loss of protein, and is possibly slightly larger for crêpe than for sheet.

(2) The second loss occurs during the drying of the

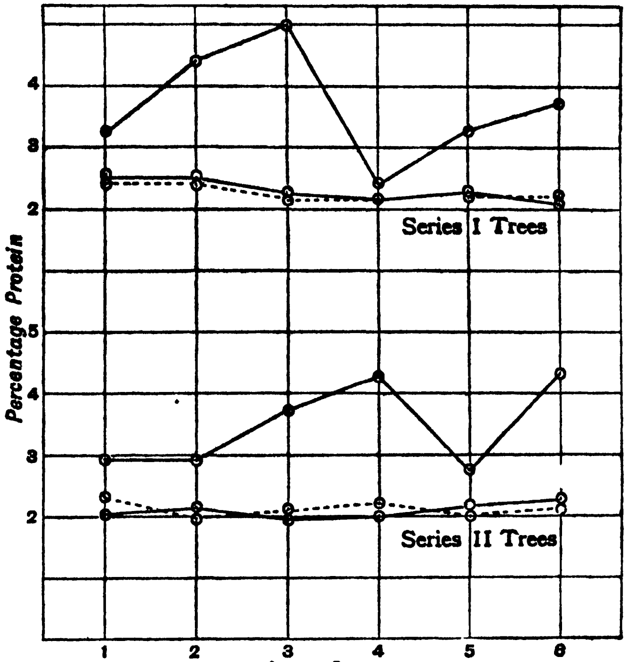


FIG. 3.—Relation between the quantity of protein in the latex and in the corresponding dry rubber.

The upper continuous line in each series represents the amount of protein in the latex; the lower continuous line, the amount in the dry rubber and the dotted line the amount in crêpe rubber.

machined coagulum. This is a large loss, and appears to go on until the rubber contains a definite amount of protein, which is independent of whether the rubber is in sheet or crêpe form.

(3) The third loss of nitrogen compounds occurs during the washing of the commercial rubber. This loss, however, is only small.

The view has been put forward that the time of vulcanisation depends largely on the nature and the

amounts of some of the proteins present in the rubber. If this is so, it follows that the protein in these samples of sheet and crêpe must differ in character, since they are about equal in quantity.

This alteration in the nature of the protein can only occur during the drying process. Hence during the drying of the machined coagulum two sets of changes appear to take place; one resulting in a loss of nitrogenous products, very similar in amount for crêpe and sheet, and the other producing a difference in the character of the protein.

Attempts have been made to correlate the times of cure with the results of the various analyses, but without success.

The examination of these samples has given interesting results, and it is desirable that the experiments should be continued in Ceylon in order that the various problems dealt with in this report may be further investigated.

Summary of the Principal Results so far obtained from Investigations conducted at the Imperial Institute under the Ceylon Rubber Research Scheme

In the course of the work carried out at the Imperial Institute in connection with the Ceylon Rubber Research Scheme, over five hundred specially prepared samples of rubber have been examined in order to determine their vulcanising and mechanical properties. In many cases the chemical composition of the rubber has also been determined. The principal questions investigated and the main conclusions to be drawn from the results are summarised in the following account. The figures quoted represent the average results obtained for all the samples examined in each group. In some experiments the results were irregular, and in these cases the general tendency has been indicated.

(1) *The Preparation of Sheet Rubber by a Standard Method*

More than ninety samples of sheet rubber were prepared by a standard method under competent supervision on several estates. The rubber from some estates almost

invariably vulcanised quickly, while that from others vulcanised slowly.

The average variation in the average time of vulcanisation of the rubber from different estates was 14 per cent. The average variation in the time of vulcanisation of the rubber from one group of trees was 8 per cent. The maximum variation in time of vulcanisation of the standard sheet rubber for the whole of the experiments was 100 per cent.

The average time of vulcanisation of standard sheet from 10-year-old trees was 14 per cent. less than the average time of vulcanisation of sheet from 16 to 20-year-old trees on the same estate.

A seasonal variation in the vulcanisation properties of the rubber could not be definitely traced, but the data available indicated that the rubber prepared between April and July vulcanised more slowly than that prepared during the remainder of the year. The time of vulcanisation could not be correlated with the amount of dry rubber in the latex, nor with the amounts of resin, protein or moisture present in the rubber.

The tensile strength of the samples was fairly uniform. The variations were irregular.

(2) *Methods of Coagulation and Additions to the Latex. Spontaneous Coagulation*

Sheet rubber, prepared from coagulum which had been allowed to develop spontaneously in the latex, was found to vulcanise in 23 per cent. less time than the corresponding sheet coagulated with acetic acid (four sets of experiments). Similarly, spontaneously coagulated rubber in the form of crêpe required 25 per cent. less time to vulcanise than crêpe coagulated with acetic acid. The times of vulcanisation of the spontaneously coagulated rubbers were irregular.

Two samples of spontaneously coagulated rubber were collected in two clots. In each case the second clot took slightly longer to vulcanise than the first clot.

Acid Coagulation.—Five series of experiments were made comparing the following acids as coagulants:

acetic, formic, lactic, sulphuric and hydrofluoric. Excess of acid was found to increase the time of vulcanisation, and in some cases to reduce the strength of the vulcanised rubber. Acetic acid was found to be the most suitable coagulant, since an excess of it had the least effect on the time of vulcanisation and the strength of the rubber.

Two lots of crêpe rubber and two lots of sheet rubber were prepared by coagulating hot latex with acetic acid. The time of vulcanisation of the sheet rubber was increased by 28 per cent., and of the crêpe rubber by 2 per cent.

Evaporation of Latex in Vacuo.—Rubber prepared by the evaporation of the latex in the vacuum drier vulcanised more quickly than any other sample.

Addition of Preservatives to the Latex.—The addition of ammonia or sodium sulphite to the latex in a quantity sufficient to prevent spontaneous coagulation for 24 hours was found, as the result of two sets of experiments, to increase the time of vulcanisation by 10 per cent. The addition of formaldehyde to the latex increased the time of vulcanisation, the effect produced being dependent on the amount of formaldehyde used. The presence of 0·01 per cent. of formaldehyde in latex increased the time of vulcanisation by 18 per cent. The strength of the rubber was not affected by these preservatives.

The addition of commercial sodium bisulphite to the latex did not have an appreciable effect on the vulcanisation properties of the resulting rubber.

A large number of experiments were made in which alkaline creosote solution was added to the latex. The results were very irregular. In the quantities tried the addition of creosote was not found to have a marked effect on the vulcanisation properties of the resulting rubber.

Addition of Caustic Soda.—The addition of caustic soda in large quantities to the latex was found to produce a rubber with a tendency to become "tacky." When sodium compounds were left in the rubber it vulcanised quickly. It was difficult to wash out the sodium compounds completely, but when this was done the rubber vulcanised very slowly. The addition of caustic soda to the latex would cause serious irregularities in the time

required for vulcanisation, and is stated to affect adversely the keeping properties of the vulcanised rubber.

Dilution of Latex.—Three sets of experiments were tried in which latex was diluted with varying amounts of water. The results showed that if latex be diluted to five or six times its volume the time of vulcanisation of the rubber is increased by about 5 per cent.

(3) *The Mechanical Treatment of the Coagulum*

As the result of seven series of experiments, it was found that machine sheet takes 40 per cent. longer to vulcanise than hand-pressed sheet; that thick crêpe takes 15 per cent. longer to vulcanise than machine sheet; and that thin crêpe takes 12 per cent. longer to vulcanise than thick crêpe. The more slowly vulcanising rubbers were not so strong as those which vulcanised quickly.

Passing the coagulum through rollers thirty-five to seventy times instead of four to five times increased the time of vulcanisation by 5 to 10 per cent. It had no effect on the tensile strength of the rubber.

Twelve sets of experiments were made in which both sheet rubbers and crêpe rubbers were prepared from the same latex. In spite of the different treatment to which they had been subjected, the rubbers contained almost identical amounts of protein. A rise or fall in the time of vulcanisation of the crêpe rubber did not coincide with a rise or fall in the time of vulcanisation of the corresponding sheet rubber.

(4) *Maturing*

Seven sets of experiments were made at different times and on several estates, with and without the addition of alkaline creosote to the latex, in which the coagulum was allowed to remain in the serum for varying periods before crêpeing. The results showed considerable variation, but they definitely established the fact that maturing the coagulum in the serum decreases the time of vulcanisation considerably, but does not reduce the variability.

Four sets of experiments were made in which crêpe rubber was blocked while still wet. This procedure

reduced the time of vulcanisation by 30 per cent., and the rubber invariably had a high tensile strength. The results were very constant.

Numerous experiments were made on the rolling up of sheet rubber containing varying amounts of moisture. These "wet" rubbers vulcanised much more quickly than the corresponding "dry" samples. The extent to which the time of vulcanisation was reduced was found to be approximately proportional to the amount of moisture retained by the rubber. The wet rubbers contained more "resin" than the corresponding dry rubbers, and the increase in this constituent was also proportional to the amount of moisture retained by the rubber. The wet rubbers were found to lose protein on washing, much more so than did the corresponding dry rubbers. The removal of protein by washing did not have much effect on the time required for vulcanisation.

Whether the wet sheet was prepared by machining the coagulum once only and then rolling up, or whether it was machined five times and then rolled up, made no difference to the vulcanisation properties of the wet roll.

(5) *Methods of Drying*

It was found that the method of drying crêpe rubber, viz. in hot air (125° F. to 140° F.), *in vacuo* (130° F. to 160° F.), or under atmospheric conditions (85° F. to 90° F.) made little difference to its vulcanising and mechanical properties. Drying rubber under tension had no appreciable effect on its properties.

(6) *Smoking*

The effect of smoking rubber varied considerably on different estates. Sheet rubber dried in smoke always vulcanised more slowly than the corresponding sheet rubber dried in air. On one estate smoking doubled the time of vulcanisation. On another it increased the vulcanisation time by 40 per cent. On a third estate the increase amounted to only 20 per cent. The first three days of smoking is generally sufficient to account for nearly half the total increase in time of vulcanisation. Smoked sheet rubber is a little weaker than plain sheet

rubber. The few experiments made on the smoking of crêpe rubber indicate that the time of cure is thereby increased.

Byrne-cured crêpe rubber required a longer time of vulcanisation (10 to 30 per cent.) as compared with the control crêpe. The results from the Byrne-cured sheet rubber were irregular and inconclusive.

Samples of rubber prepared according to the Wickham process vulcanised quickly and were fairly strong. They contained about 10 per cent. of moisture, which probably accounted for their short time of vulcanisation.

An attempt was made to prepare samples of rubber according to the Brazilian process. On arrival at the Imperial Institute the samples contained only about 2·5 per cent. of moisture, and were thus much drier than Para rubber from Brazil. They gave good results, but, on account of the low percentages of moisture, were not strictly comparable with samples of fine hard Para.

(7) *Chemical Composition of Latex*

Twelve lots of latex were each converted into a sample of crêpe and sheet rubber. No relation could be discovered between the amount of protein in th latex and in the washed, dry rubber, nor between the amount of protein in the latex and the time required to vulcanise the corresponding samples of sheet and crêpe rubber. On coagulation, the bulk of the protein in the latex was retained by the coagulum, but much of this protein was lost during subsequent processes.

(8) *Scrap Rubber*

Scrap rubber was found to have a low tensile strength after vulcanisation. This inferiority was shown to be due chiefly to the presence of foreign matter consisting of sand and, to a lesser degree, bark. The tensile strength of these rubbers is improved by prolonged washing.

APPENDIX

Results of Trials of Ceylon Plantation Rubber for the Manufacture of Ebonite

These samples of rubber were prepared under supervision on an estate in Ceylon, and consisted of (1) wet

creosoted roll, (2) wet "slab," (3) heavily smoked sheet, and (4) plain sheet (control). The samples were specially prepared at the request of the London Advisory Committee in order that the suitability of these types of plantation rubber for the manufacture of ebonite under the Admiralty specification might be determined.

Description

(1) Wet creosoted roll. Weight 71 lb.

Two large rolls composed of creosoted sheet from $\frac{3}{16}$ to $\frac{1}{4}$ in. thick. The rolls were dark brown to black externally, and moist and white within; some liquid was present between the layers of the rolls.

(2) Wet "slab." Weight 62½ lb.

Slabs of rubber from ⅛ to ⅜ in. thick, dark brown to black externally, and white and moist within.

(3) Heavily smoked sheet. Weight 56½ lb.

Smoked diamond sheet, about $\frac{3}{16}$ in. thick, and almost black.

(4) Control sheet. Weight 53 lb.

Smooth sheet, about ¼ in. thick, and of dark brown colour. The central portions of the sheets were moist and opaque.

Results of Examination

(a) Chemical Examination

The samples were analysed at the Imperial Institute, with the following results:

	Loss on washing.	Composition of washed and dried rubber: Caoutchouc.	Resin.	Protein.	Ash.
	Per cent	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
(1) Wet creosoted roll	15·5	94·72	3·58	1·56	0·14
(2) Wet slab	14·2	96·04	2·45	1·25	0·26
(3) Heavily smoked sheet	0·4	94·33	3·38	2·07	0·22
(4) Plain sheet (control)	1·1	95·24	2·78	1·78	0·20

It will be seen that the washed and dried rubbers showed some variation in the amounts of resin and protein present, the percentages of resin ranging from 2·45 to 3·58 and of protein from 1·25 to 2·07.

(b) Vulcanisation and Mechanical Tests

The rubbers were submitted to vulcanisation and

mechanical tests at the Imperial Institute under the usual conditions, with the following results :

	Time of vulcanisation. *Mins.*	Tensile strength. *lb. per sq in.*	Elongation. *Per cent.*	Permanent set. *Per cent.*
(1) Wet creosoted roll	51	2,390	877	2·8
(2) Wet slab	50	2,530	897	2·7
(3) Heavily smoked sheet	90	2,340	892	2·6
(4) Plain sheet (control)	68	2,470	886	2·9

These results are in general agreement with those usually obtained with similar classes of rubber. The time of vulcanisation of the wet rubbers is shorter than that of the control sheet, whilst that of the smoked sheet is longer. The tensile strength is good in all cases, the best result, viz. 2,530 lb., being given by the wet slab rubber.

(*c*) *Ebonite Tests*

The North British Rubber Company kindly undertook to manufacture the rubber into ebonite, and the tests of the dielectric strength of the products were made at the National Physical Laboratory. The sheets of ebonite tested were each $\frac{9}{16}$ in. thick, and gave the following results :

	Dielectric strength, volts per mm.
(1) Wet creosoted roll	Withstood 125,000 volts for 20 seconds.
(2) Wet slab	Withstood 125,000 volts for 1 minute.
(3) Heavily smoked sheet	Withstood 125,000 volts for 2 minutes. Breakdown voltage, 161,000.
(4) Plain sheet (control)	Withstood 125,000 volts for 15 seconds.

The Admiralty specification requires that ebonite shall withstand a pressure of 125,000 volts per mm. under the prescribed conditions.

The specimens of ebonite made from these plantation rubbers all passed the Admiralty test, the best result being given by that from the heavily smoked rubber. The latter rubber did not differ appreciably in composition from the wet creosoted roll, so that it would appear that the heavy smoking may lead to a physical rather than a chemical difference in the rubber on which the superiority of the ebonite is dependent.

The Committee are informed that in similar tests with commercial plantation rubber conducted by the North British Rubber Company ebonite made from a heavily smoked sheet also gave the best results.

INDIAN ARTEMISIA AS A SOURCE OF SANTONIN

SANTONIN, which is used widely as a vermifuge, is obtained commercially from the so-called wormseed, which consists of the unexpanded flower-heads of *Artemisia maritima*, var. *Stechmanniana*. Supplies of wormseed come almost entirely from Russian Turkestan and, owing to the monopoly created in this product, santonin has risen greatly in price; in 1913 it was sold wholesale at about £5 per lb. but is now quoted at £36 per lb. Although there is no very great demand for the drug, it occupies a somewhat unique position in medicine as there is no satisfactory substitute for it, and for this reason it becomes of importance to discover new sources. With this end in view a species of Artemisia which occurs in Kashmir and neighbouring countries has been investigated. The plant was at first thought to be a form of *Artemisia maritima*, but it is now known to be a distinct species, *A. brevifolia*, Wallich.

A sample, consisting of dried leaves and small stems of the plant with only a few flower heads, was received from Kashmir for examination at the Imperial Institute in May 1922, whilst later in the year material collected at four different stages of growth was received. A representative portion of the first sample was found to contain 11·00 per cent. of moisture and 0·83 per cent. of santonin, equivalent to 0·93 per cent. expressed on the dry material. Commercial wormseed (consisting of flower heads only) usually contains from 2 to 3 per cent. of santonin, so that from the manufacturing point of view the yield from the present sample was rather low.

The further samples examined were as follows:

No. 1.—" Leaves and flower buds collected on July 8, 1922, in Garez, Kashmir."

No. 2.—" Leaves, flower buds, etc., collected on July 16, 1922, in Garez, Kashmir."

No. 3.—" Flower buds collected on July 26, 1922, in Garez, Kashmir."

No. 4.—" Flower buds collected on August 7, 1922, in Garez Ilage, Kashmir."

The samples consisted of greenish-grey dried plant tops. No. 1 was composed almost entirely of leaves and small stems with no definite appearance of flower buds, and No. 2 was generally similar but the flower buds were more developed. Nos. 3 and 4 contained a fair proportion of flower buds, which were more fully developed in No. 4 than in No. 3.

The material was chemically examined at the Imperial Institute with the following results :

	No. 1 *Per cent.*	No. 2 *Per cent.*	No. 3 *Per cent.*	No. 4 *Per cent.*
Moisture	11·0	7·4	9·3	8·8
Santonin, in material as received . .	0·82	1·21	0·97	1·64
Santonin, expressed on the dry material	0·92	1·31	1·07	1·79

The results show that in general the amount of santonin in the plant gradually increases with its growth up to the stage represented by Sample No. 4 collected on August 7. The fact that No. 3 contained a lower percentage of santonin than No. 2 is possibly attributable to the presence in No. 3 of a larger proportion of stalk.

Part of Sample No. 4 was separated into two portions, viz.: (1) flower-buds and leaves (83 per cent.) and (2) stalks (17 per cent.), and the santonin in each was determined separately. The following results, which are expressed on the moisture-free material, were obtained :

	Santonin. *Per cent.*
(1) Flower-buds and leaves	1·95
(2) Stalks (thick stems excluded)	1·19

It will be seen that the flower-buds and leaves contain a distinctly higher proportion of santonin than the stalks, but it is noteworthy that the latter yield as much as 1 per cent. of santonin. If the stalks were excluded during collection it would be possible to obtain material containing about 2 per cent. of santonin from plants at the stage of maturity represented by Sample No. 4.

The results of examination of the present samples indicate that the percentage of santonin present increases with the development of the flower-buds. The best time to collect the material cannot, however, be definitely stated until specimens of the plant in a later stage of development have been examined.

Prof. H. G. Greenish and Miss C. E. Pearson, who examined the whole plant in 1921, found it to contain 0·85 per cent. of santonin (*Pharm. Journ.*, 1921, [4], **52**, 2). This corresponds closely with the results obtained with the first sample examined at the Imperial Institute. In a subsequent paper (Greenish and Maplethorpe, *Pharm. Journ.*, 1923 [4], **111**, 94), it was stated that from the examination of a further sample it appeared that the leaves are the only part of the plant which contains santonin.

Dr. J. L. Simonsen, in *Journ. of Indian Industries and Labour* (1921, **1**, 539), records the results of examination of a series of specimens of the Kashmir plant, collected at various dates between July 9 and October 2, 1920. In this case it was found that the highest yield, viz. 1·0 per cent., was obtained from the youngest material and the lowest yield, 0·5 per cent., from the oldest. This result does not agree with those of the Imperial Institute investigation described above, but further work is necessary before final conclusions can be reached.

Manufacturers considered that in view of the present high prices of santonin, it would be remunerative to extract it from material containing as little as 0·9 per cent., and stated that if immediate supplies of material of this quality were obtainable they would be prepared to purchase a consignment. It is understood that a large quantity of material collected by the Kashmir Forest Department is now available for export.

ESSENTIAL OIL OF *STIRLINGIA LATIFOLIA* FROM WESTERN AUSTRALIA

In 1918 a sample of essential oil distilled in Western Australia from the plant *Stirlingia latifolia* was received at the Imperial Institute. It was stated that the oil appeared to consist almost entirely of acetophenone and information was desired as to whether it would be of commercial value. Acetophenone has remarkable soporific properties and is employed in medicine under the name of "hypnone." Hitherto all supplies have been prepared synthetically, the only previous record of its occurrence

in a natural oil being in the oil of gum labdanum (H. Masson, *Compt. Rend. de l'Acad. Sci.*, 1912, **154**, 517).

Stirlingia latifolia, Steud., is a small shrubby plant belonging to the Proteaceæ. It is stated to occur abundantly in the coastal plains of Western Australia from Geraldton in the north to the Busselton district in the south, so that ample supplies would be obtainable if it were desired to produce the oil on a commercial scale. The yield of oil obtained by the distillation of fresh plants with steam was 0·75 per cent., whilst young shoots gave a yield of 1·0 per cent. It is understood that the best results are obtained from material gathered during the period April to July.

The oil received at the Imperial Institute was found to have the following constants compared with those of acetophenone:

	Stirlingia latifolia oil.	Acetophenone.
Specific gravity at 15° C.	1·0310	1·0329
Boiling point	195°–205° C.	202° C.
Optical rotation	+ 0·2°	inactive

The oil furnished a large yield of acetophenone-oxime (m.p. 58°–59° C.), the identity of which was further proved by its conversion into acetanilide (m.p. 115°–116° C.) by Beckmann's reaction.

These results confirm the report from Australia that the oil consists almost entirely of acetophenone.

A supply of dried stems and leaves of the plant was subsequently received from Australia. On distillation with steam, the stems as received yielded 0·35 per cent. of a pale yellow volatile oil, which had the following constants, compared with those of the oil previously examined.

	Present sample.	Previous sample of oil.
Specific gravity at 15/15° C.	1·0256	1·0310
Boiling point	199°–205° C. (mostly 202°–203°)	195°–205° C.
Optical rotation αD	nil.	+ 0·2°

The odour of the oil was less pleasant than that of the oil distilled from the fresh plant in Australia. It will, however, be seen that the constants are almost identical in the two cases, and that, like the previous sample, the oil consisted almost entirely of acetophenone.

It is to be observed that the yield of oil was very low,

viz. only 0·35 per cent., as compared with a reported yield of 0·75 per cent. from the fresh plant, and this indicates the possibility that a loss of oil took place during the drying of the plant.

Apart from its use in medicine as a hypnotic, acetophenone has been employed in soap perfumery, and is stated to blend well with terpineol, coumarin, heliotropin, and perfumes of the lilac and new-mown-hay types. It was thought possible, therefore, that the Stirlingia oil would find a market for this purpose in place of pure acetophenone.

As a result of commercial enquiries which were made by the Institute, it was ascertained that if the oil could be produced at a low enough price to enable it to be employed as a source of acetophenone in competition with that manufactured synthetically, it might be possible to market the oil in this country. It was stated, however, that acetophenone has not hitherto been used in very large quantities, and that firms are not prepared to experiment with a new product of this kind unless they can be assured of the possibility of obtaining regular supplies at definite prices.

The question of finding a market for the Stirlingia oil in this country at the present time appears to depend (*a*) on the feasibility of offering it at about 5*s*. per lb., and (*b*) on the prospect of regular commercial supplies being obtainable. As, however, the plant only yields 0·75 per cent. of oil it hardly seems likely that at the price mentioned it will be profitable to collect and distil it on a commercial scale.

AUSTRALIAN POTTERY CLAY. II

In this Bulletin (1921, 19, 465) the results were given of an investigation, conducted at the Imperial Institute, on the suitability of a white clay from Bendigo, Victoria, for the manufacture of porcelain and refractory bricks. It was shown that the clay, after washing to remove gritty matter, was suitable for the manufacture of white permeable pottery, which could be glazed to yield a fine white earthenware, and could also be used, in admixture with "grog"[1] for the production of second-grade refractory bricks. It was pointed out that if it were proposed to use the clay in Australia for the manufacture of "semi-porcelain" or impermeable stoneware, it would be desirable to carry out further trials with the clay in conjunction with felspathic and siliceous materials available for the purpose. In accordance with this suggestion a supply of clay, felspar and quartz was forwarded to the Imperial Institute in October 1922, and the results of examination of the materials are given in the following pages.

The clay received was greyish in colour, plastic, and practically free from grit, being superior in this respect to the material examined in 1921. It formed a very plastic mass when mixed with water.

The felspar was pale pink in colour, and probably represented a soda microcline considerably altered (especially along the cracks) and partially converted into china-stone.

The quartz was massive and milky-white.

Chemical Analysis

Clay.—The results of chemical analysis of the clay as received are given in the following table, together with the corresponding figures obtained for the previous sample after washing (this Bulletin, 1921, 19, 465):

[1] Washed clay which has been fired to a temperature of about 1600° C. and then ground to pass a sieve having 20 meshes per linear inch.

		Present sample. (as received). Per cent.	Previous sample. (after washing). Per cent.
Silica	SiO_2	59·70	65·25
Alumina	Al_2O_3	24·85	22·16
Ferric oxide	Fe_2O_3	1·45	0·87
Titanium dioxide	TiO_2	nil	0·59
Lime	CaO	nil	0·38
Magnesia	MgO	1·37	0·82
Potash	K_2O	2·30	1·68
Soda	Na_2O	1·66	0·42
Loss on ignition		8·88	7·58

It will be noticed from the above figures that the present material, as received, contained less silica and more alumina than the washed clay previously analysed, and that the percentage of alkalis (potash and soda) was considerably higher.

Felspar.—The felspar, after being roughly freed from adherent matter with a hard brush, gave on analysis the following results :

		Per cent.
Silica	SiO_2	65·34
Alumina	Al_2O_3	19·96
Ferric oxide	Fe_2O_3	0·47
Titanium dioxide	TiO_2	nil
Lime	CaO	nil
Magnesia	MgO	0·60
Potash	K_2O	7·96
Soda	Na_2O	4·44
Loss on ignition		0·56

Quartz.—The specimen of quartz remained white after being raised to a high temperature, and as it was evidently of high purity (thus consisting entirely of silica) no chemical analysis was considered necessary.

Stoneware Trials

On account of the high proportion of alkalis present the clay vitrified readily, and formed a dense impermeable body when raised to a suitable temperature. It could, therefore, be used for the production of stoneware without previous admixture with other materials. The colour of the product so obtained, however, was not good, and it may be desirable to produce a rather more siliceous body than that yielded by the clay alone, whilst the addition

of silica is also of advantage in extending the vitrification range of the clay.

Experiments were, therefore, made at the Imperial Institute in order to determine the most suitable mixture to be employed for stoneware. The flint and felspar employed were ground in a ball-mill and passed through a sieve of 180 meshes to the linear inch.

Vessels moulded from the following mixtures were raised gradually to a maximum temperature of about 1320° C., at which they were maintained for a short time:

	1	2	3	4	5	6	7	8
Clay *per cent.*	100	80	70	70	60	60	50	50
Felspar *per cent.*	—	—	—	10	10	30	30	20
Quartz *per cent.*	—	20	30	20	30	10	20	30

The approximate percentage composition of these mixtures after firing would be as follows:

		1	2	3	4	5	6	7	8
Silica	SiO_2	65·5	72·4	75·8	72·4	75·9	69·0	72·5	75·9
Alumina	Al_2O_3	27·3	21·8	19·1	21·1	18·4	22·4	19·7	17·7
Alkalis	$\left\{\begin{matrix} Na_2O \\ K_2O \end{matrix}\right\}$	4·3	3·4	3·0	4·3	3·8	6·3	5·9	4·7

It will be seen that several of the mixtures are very similar in composition, and in fact the firing trials showed that there is not much difference in the quality of these for the production of stoneware, although on the whole Nos. 3 and 5 were the most satisfactory.

It will be noticed that mixtures Nos. 2 and 3 contained no added felspar. The addition of this material to the clay appears to be desirable only in small amounts, in order to make a more fusible body and thus reduce the temperature required for satisfactory firing.

The colour of the vessels made from mixtures Nos. 3 and 5 after firing was better than that of the vessel made from the clay alone. Mixtures Nos. 6, 7 and 8, containing relatively high percentages of added felspar, proved unduly fusible and showed a tendency to blister.

The contraction and porosity (the latter being measured by the water absorption) of some of the fired bodies are given below:

Mixture.	Shrinkage on air drying. *Per cent.*	Additional shrinkage on firing. *Per cent.*	Porosity (water absorption). *Per cent.*
1	6·0	7·0	nil
3	5·6	7·4	3·7
5	6·0	6·0	0·35

The porosity shown by mixtures Nos. 3 and 5 is not serious, and could be obviated by more prolonged firing or by covering the ware with a suitable glaze. Salt-glazing could be employed, in which case siliceous bodies such as Nos. 3 and 5 would be preferable to the more aluminous clay body No. 1.

A calcareous felspathic glaze of the following composition was tried at the Imperial Institute :

		Per cent.
Present materials	Clay	20
	Felspar	28
	Quartz	34
Calcium carbonate		16
Magnesia		2

This glaze gave satisfactory results after firing at 1320° C., as also did the same glaze rendered opaque by the addition of 10 per cent. of pure stannic oxide. The best result was, however, obtained by the use of a commercial hard French stoneware glaze of a felspathic nature.

Conclusions

The results of the tests showed that the clay is quite suitable for use in the manufacture of stoneware or semi-porcelain ; it would be advisable, however, for large scale trials to be carried out in order to determine the working properties of the clay under industrial conditions.

It should be noted that this clay and the previous sample from the same locality show considerable differences in composition, and it thus appears likely that the clay varies in different parts of the deposit. Careful chemical control would, therefore, be necessary when actual manufacturing operations are undertaken.

GENERAL ARTICLES

THE LIGNITE DEPOSITS OF NIGERIA

Considerable attention has recently been directed to the possibility of utilising the brown coals and lignites which occur in certain parts of the Empire, and, in view of this, it has been thought desirable to publish a résumé of the work which has been carried out by the Imperial Institute on the lignites of Southern Nigeria which were brought to light during the Mineral Survey of Southern Nigeria. This Survey was initiated by the Institute and led to several discoveries of importance. The preliminary investigation of the lignite had just been completed when important deposits of bituminous coal were discovered at Udi (this Bulletin, 1914, **14**, 369) and attention was therefore diverted to the development of the coal.

In 1904 a sample of lignite from Ibusa, on the right bank of the Niger, in the Asaba District of Nigeria, was forwarded for examination to the Imperial Institute by the Principal Officer of the Mineral Survey, which was being carried on in conjunction with the Institute. This lignite proved to be of good quality as a fuel.[1]

In 1905 the Officers of the Mineral Survey made an inspection of the lignite outcrops near Ibusa and Okpanam, about ten miles from the river Niger. A number of samples were collected and examination of these at the Imperial Institute confirmed the opinion that the lignite was of good quality and would form a useful fuel.

In 1906 the Survey examined an exposure of lignite at Moroko in the Abeokuta District near the river Ogun (see p. 335) which proved to be of similar quality to that from the Asaba district.

In view of the importance of these discoveries, the deposits at Okpanam and Moroko were examined in

[1] For details of the results of the examination of this and the numerous other samples of lignite received at the Imperial Institute from Asaba and other localities, the *Reports on the Results of the Mineral Survey of Southern Nigeria* should be consulted (*Colonial Reports*—Miscellaneous Series [Cd. 2876], pp. 9 and 18; [Cd. 4994], p. 19; [Cd. 4995], pp. 14 and 24; and [Cd. 5901], p. 16).

greater detail, and an extensive series of samples was collected and examined at the Imperial Institute. In the same year lignites of good quality from deposits at Obompa in the Asaba district (see p. 332) and lignitic material from near Ohe in the Benin City District (see p. 336) were also received at the Institute.

In 1908–9 another large deposit of lignite was discovered near Newi, a district on the left bank of the Niger, about thirteen miles from the river (see p. 334).

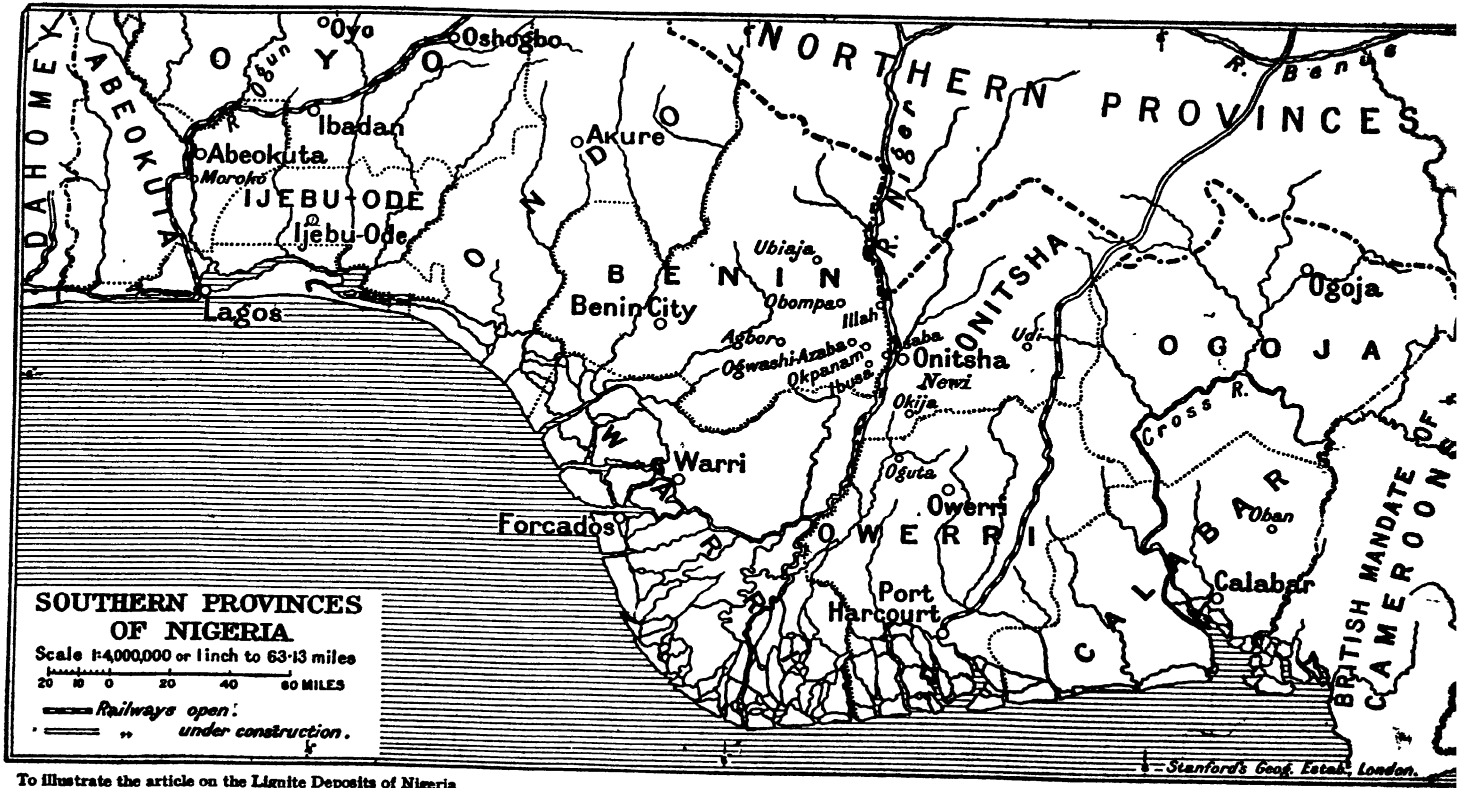
These investigations having shown the presence of large deposits of good lignite in Nigeria at points near the navigable part of the Niger and conveniently situated for their exploitation, it was considered desirable to investigate the practicability of mining this lignite and using it as a steam-raising fuel for locomotives and river-steamers since it was for these purposes that coal was then largely imported to British West Africa. In view of the experience in Germany and Bohemia, it was considered that the use of Nigerian lignite for fuel purposes in West Africa should present no serious difficulty.

In the following pages a summary is given of the information available on the geological relationships of the lignite deposits of the Southern Provinces of Nigeria; their situation and extent; the composition of lignite from the more important of the deposits as determined at the Imperial Institute in comparison with typical lignites from various parts of Germany and Bohemia; and the results of briquetting trials with Nigerian lignite in this country and in Germany. Particulars are also given of the results of firing trials with Okpanam lignite briquettes in Nigeria.

It should be mentioned that throughout this article the Nigerian material is referred to as "lignite" or "brown coal," these terms being taken as synonymous.

Geological Relationships

In the Southern Provinces of Nigeria the known sedimentary rocks, which are all of Cretaceous or later geological age, occupy most of the country south of latitude 7° N. with the exception of the Oban Hills in the extreme east.



To illustrate the article on the Lignite Deposits of Nigeria in the *Bulletin of the Imperial Institute*, 1923, vol. xxi. No. 2.

The relations between the various series of deposits represented are rather obscure, fossil evidence being extremely meagre, but it is considered that the oldest beds are of Upper Cretaceous age. These consist of a variable series of marine and estuarine fossiliferous shales, mudstones, limestones, and grits, occupying the south-east portion of the Colony flanking the Oban Hills and extending into the Northern Provinces. Westwards they grade into freshwater beds of similar character containing seams of coal. Still further west these beds are overlain by a thick series of rocks known as the "Benin Sands Series," but the true relationship between this series and the Upper Cretaceous beds below is not known.

The Benin Sands Series is divisible on lithological characters into upper and lower groups of beds. The upper portion consists of a great thickness of bright red argillaceous sands, unstratified and devoid of fossil remains, known as the Benin Sands, or "red-beds," which occupy most of the country between a line drawn from Abeokuta eastwards to the Niger and the coastal belt of alluvium, and overlap the ancient crystalline complex on the north forming a steep escarpment.

Between the Benin Sands and the underlying Lignite Series there is an unconformity. The latter beds have been located below the Benin Sands at many places in the provinces of Benin and Onitsha where streams have cut their valleys sufficiently low down through the red sands to expose them. They consist of freshwater shales, mudstones, clays and grits, and include many seams of excellent lignite, sometimes more than 20 feet thick, containing plant remains.

From the small amount of fossil evidence available, the Benin Sands Series of rocks has been considered to be of Tertiary age, the Lignite Series being provisionally referred to the early Eocene and the Benin Sands to the Pliocene.

The known outcrops of the Lignite Series are described below in detail, but there is no reason to suppose that the lignite is restricted to the localities where outcrops have been observed. It probably occupies a constant geological horizon, and because the rocks in which it occurs

have been but little disturbed by earth movements since their deposition, the lignite probably underlies a considerable area of the Benin Sands, except where it has been removed by contemporaneous erosion prior to the deposition of the sands. It was, in fact, suggested by the Principal Mineral Surveyor of Southern Nigeria that the lignite might be found to extend more or less continuously from the Niger to the Ogun, a distance of about 200 miles from east to west.

Distribution and Composition of the Lignite

Okpanam—Ibusa District, near Asaba

Asaba lies in Benin province on the right bank of the Niger immediately opposite to Onitsha (latitude 6° 10′ N.; longitude 6° 47′ E.). Ibusa is about six miles W.S.W. of Asaba, and Okpanam is four miles N. of Ibusa on the Asàba-Agbor road. A metalled road has been constructed from Asaba westwards to the lignite workings.

The lignite in this district forms several distinct seams which are almost horizontal and consequently are exposed only in the beds and banks of the Atakpo River and its tributaries. The main seam has a thickness of 12 ft. 9 in. where proved by a hand bore close to the face of the workings at the end of the road from Asaba. At other points in the heads of streams to the north-west of this place its thickness, as proved by hand bores, is 23 ft., 17 ft. 10 in., and 18 ft., respectively.

These streams rise in the old plateau which lies between the valley of the Atakpo and that of the Anwai to the north, and the Okpanam town seams occur at the end of the remnant of this plateau. The Anwai valley, as far as explored, does not show any tributary valleys on its southern side, and consequently the northern extent of the main seam has not been proved and probably cannot be proved without boring with a large machine drill.

The outcrops of lignite already proved in the Atakpo valley extend over a wide area, and judging generally by appearances, the seams have a still larger distribution, occupying probably the greater portion of the plateau area about Ogwashi-Azaba, Issele-Azaba and Okpanam

beneath the Benin Sands. Near the main outcrop, which is close to Okpanam, at the point where the natives obtain water, there is evidence of erosion of the main seam before the deposition of the overlying Benin Sands. This unconformity is of great importance when considering the probable amount of lignite available in this area, but on the whole the evidence shown in the head waters of the Atakpo indicates that there is in the district a widespread deposit of lignite in this main seam. It is also quite likely that the smaller seams in the area are of greater thickness in directions to the north-east and to the west than where outcrops are seen in the Atakpo and its tributaries.

The development of the main seam offers no difficulty, as it can be opened up by open-faced workings or by adits, and since the area does not show evidence of much

Locality.	Thickness of seam.	Remarks.
Okpanam District:	ft. in.	
Sources of Atakpo river:		
'Mbwuliba stream (source), Ogwashi-Azaba	17 10	Main seam; good lignite throughout.
Tributary of 'Mbwuliba stream, near Ogwashi-Azaba	18 9	,, ,, ,, ,, ,,
Iyokwa Stream	19 0	,, ,, ,, ,, ,,
Iyunku stream (eastern branch of Atakpo)	23 0	,, ,, ,, ,, ,,
Camp stream	12 9	Main seam.
'Mbwuliba stream (main Atakpo).	4 3	Seam above main seam. Good lignite.
,, ,, . . .	1 0	Seams below main seam; chiefly good lignite.
,, ,, . . .	3 3	
,, ,, . . .	3 0	
,, ,, . . .	0 11	
,, ,, . . .	1 3 to 5 9	
Iyunku stream	1 6	Seam above main seam; good lignite.
,, ,, ...	2 0	,, ,, ,, ,, ,, ,,
,, ,, ...	2 0	Seam below main seam; fair lignite.
,, ,, ...	1 0	,, ,, ,, ,, ,, ,,
Ngenni stream (tributary of Atakpo)	3 3	Mostly good lignite; a little of it fair.
Nemi stream (tributary of Atakpo)	1 4	Good lignite.
'Mbwuliba stream, Okpanam town	5 0	Upper seam; good lignite.
,, ,,	5 6	Lower seam; good lignite.
Ibusa District:		
Oboshi river, near Ibusa . .	6 4½	Upper seam; good lignite
,, ,, ,, ,, . .	5 9	Lower seam; good lignite.
Oboshi river, tributary, near Ibusa .	2 0	Upper seam; good lignite.
,, ,, ,, ,, ,, .	1 2	Lower seam; good lignite.

earth movement only slight discontinuities are likely to be encountered.

In the Ibusa district the two largest seams, 6 ft. 4½ in. and 5 ft. 9 in. thick, outcrop in the bed of the Oboshi River, just north of the point where the path from Ibusa crosses the stream. Here again the beds are almost horizontal, but the greater part of the lignite is below stream level so that shafts would probably have to be sunk in order to develop this exposure. These beds probably extend indefinitely to the north-west beyond Ogwashi-Azaba, but as that area has not been examined nothing more can be said than that lignite has been reported from that locality.

Until further explorations have been made it is not possible to state even approximately the total amount of lignite available in this district, but a rough estimate of the material which exists near Okpanam, around the sources of the Atakpo alone, shows that the amount is probably between 11 and 12 million tons.

A marked advantage of this district is its proximity to the river Niger, which would provide a ready means of transport during certain seasons of the year.

A list of outcrops in the Okpanam Ibusa district is given on p. 330.

The following tables summarise the results of analyses [1] made at the Imperial Institute of samples of lignite from the Okpanam-Ibusa district, including one consignment of 10 tons which had been specially obtained for briquetting trials (see p. 341):

Samples from the Atakpo Valley, Okpanam

	Average.	Best.	Consignment of 10 tons.	The consignment dried to 10 per cent. of moisture (calculated).
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Volatile matter	44·86	52·86	42·36	52·53
Fixed carbon	29·48	33·28	25·84	32·04
Water	11·81	8·90	27·42	10·00
Ash	13·85	4·96	4·38	5·43
Sulphur	1·10	0·54	—	—
Calorific value, calories	5,402	6,703	5,018	6,189

The excessive amount of moisture in the consignment of 10 tons is due to the fact that it had not been allowed to

[1] For details of these analyses see pp 14–27 of the *Report on the Results of the Mineral Survey of Southern Nigeria for* 1906–7 [Cd. 4995].

dry thoroughly in air. If this had been done the results would have been equal to the average given above.

Samples from Oboski Stream, Ibusa

	Average. Per cent.	Best. Per cent.
Volatile matter	47·01	51·20
Fixed carbon	31·18	28·73
Water	9·44	8·47
Ash	12·37	11·60
Sulphur	1·61	1·38
Calorific value, calories . . .	5,597	6,145

Obompa (Obonkpa) District

The outcrops of lignite known in this district (about 24 miles N.W. of Asaba) are found in the beds of two small streams, which rise a little to the west of Obompa (Obonkpa) and flow westwards from that place. A thickness of about 80 ft. of lignite in six seams has been proved in a total thickness of strata of about 250 ft. The district is deserving of careful examination, as the deposits already found occur some 6 or 8 miles away from the Otor River, which runs into the Niger and which would be navigable for small river boats if cleared of snags. Lignite outcrops have been stated to occur in the Iyodo stream some miles to the north of Obompa, and other extensions of the deposits are likely to be found nearer the navigable part of the river.

In this district the configuration of the ground would allow the lignite deposits to be worked by means of adits.

The following is a list in descending order of the outcrops seen :

Locality.	Thickness of seam.	Remarks.
	Ft.	
Iyiokolo stream (tributary of Iyiawku stream), Obompa	20 [1]	Good lignite.
Iyiawku stream, Obompa . .	10	Part good and part fair lignite.
" " " . .	20 [1]	Part good and part fair lignite.
" " " . .	8	Good lignite.
" " " . .	9	Part good, part woody and part fair lignite.
" " " . .	10	Good lignite.

[1] *Estimated from observed outcrops.*

Analyses of samples of lignite from Obompa carried out at the Imperial Institute gave the following results :

	Maximum *Per cent.*	Minimum *Per cent.*	Average *Per cent.*
Volatile matter	48·13[1]	35·94	41·11
Fixed carbon	35·68[1]	22·52	29·19
Moisture	11·92[1]	7·50	9·51
Ash	34·04	4·27[1]	16·85
Sulphur	4·63	1·24[1]	2·67
Calorific value, calories	5,963[1]	3,654	4,766

[1] *These results were obtained from the same sample, a lignite of good quality taken from the uppermost 4 feet of the top seam exposed in Iyiawku stream.*

Ubiaja District

To the north-west of Obompa, lignite is found in the valley of the Adaji stream, Ubiaja latitude 6° 40′ N. and longitude 6° 20′ E. The largest seam is 5 ft. in thickness, and the quality is mostly good.

The small size and remote position of the seams would prevent their being worked economically, except for local use. They can be worked by adits.

The following is a list of the outcrops seen :

Locality.	Thickness of seam. Ft.	in.	Remarks.
Adaji stream, Ubiaja		8	The lignite in these seams is chiefly of good quality though apparently a little inferior to that of the Okpanam district.
" " "	1	6	
" " "	3	0	
" " "		6	
" " "	5	0	
" " "		6	

Below are summarised the results of analyses of lignite from the Adaji stream, Ubiaja, made at the Imperial Institute :

	Maximum *Per cent.*	Minimum *Per cent.*	Average *Per cent.*
Volatile matter	50·04	27·44	40·13
Fixed carbon	37·30	19·11	25·97
Moisture	10·70	7·33	9·33
Ash	44·27	8·92	27·35
Sulphur	3·15	0·92	2·17
Calorific value, calories	5,978	3,137	4,522

On the whole, the samples from the 5 ft. seam gave the best results.

Although beds of lignite have not yet been recorded, the series of rocks in which they characteristically occur has been recognised at Ogodo, Illah, Obrubru and Okala, all of which lie in the district between Asaba and Ubiaja.

Newi District

The deposits of lignite in the Newi district, on the left bank of the Niger about 14 miles S.S.E. of Onitsha, were located by the Officers of the Mineral Survey in December 1908. Two seams, one 12 ft. thick and the other 5 ft. thick, occur at the sources of the Eze stream in the Uruago locality. The Eze, which rises in a deep gulch carved out of the plateau by about a dozen small steep-graded creeks supplied with water by strong springs, crosses the Onitsha-Oguta road about a mile north-west of Newi. A number of other exposures have been located in neighbouring districts.

The following is a list of the outcrops seen in the Newi District and surroundings :

Locality.	Thickness of seam. Ft.	in.	Remarks.
Newi District :			
Eze stream, Ichi and Uruago	12	0	Good lignite.
" " " " "	5	0[1]	Good lignite. Full thickness not ascertained as upper portion of seam has been eroded.
Mpaji stream, Uruago	2	3	Part good lignite, part fair.
Edo stream, Ichi	1 3 to 2	3	Fair lignite.
Ekulu stream, Ichi	2	6	Fair lignite.
Eze stream, Omodimi	7	0	Good lignite.
Ugunzu stream, Omodimi	6	10	5 ft. of good lignite.
Omaiella stream, Omodimi	2	9	Good lignite. Outcrops also occur in tributaries of the Omaiella.
Obaneno stream, Omodimi	2	9	Good lignite.
" " "	3	3[1]	Good lignite.
Okwaka stream, Omodimi	2	0[1]	Good lignite.
Awdaga stream, Otolo	1	10	Fair lignite.
Ukpor District :			
Obelele stream, Omo Osu, Ukpor	2	0	Fair to good lignite.
Obo River tributary stream, Omo Osu, Ukpor	3	0[1]	" " " "
Ifita, Ibolo District :			
Ekulu stream, Ifita	3	0	Good lignite.
Ifita Valley	7	3	Good lignite.
Ihiala, Ukpor District :			
Okpo stream, Ihiala	0	7	Poor, shaly lignite.
Ogwisuza stream, Ihiala	0	7	" " "

[1] *Exposed thickness only.*

The 12 ft. seam occurring in the head waters of the Eze has a possible extension of some miles to the east and

west, but the work done in the locality was not sufficient to enable a definite opinion to be expressed. The Eze valley has been eroded out of that portion of the Lignite Series which contains the thick seam, but it is probable that there is an area of at least 2 to 3 square miles in which the seam is from 7 ft. to 12 ft. in thickness. Work can be carried on at the source of the Eze on the 12 ft. seam and on the second seam by adits. In this locality the lignite basin is probably connected with that of Ifita to the south-west and west between Newi and the Niger. The seams in the Ukpor and Ihiala areas near Newi are too small to be of any present economic importance except as local sources of fuel.

The results of analyses of a number of samples of the Newi lignite are summarised in the following table, which also gives the analysis of a consignment of this lignite received at the Imperial Institute for briquetting trials.

	Maximum.	Minimum.	Average.	Consignment of one ton.	The consignment dried to 10 per cent. of moisture (calculated).
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Volatile matter	48·17	41·15	44·91	39·31	44·59
Fixed carbon	35·60	29·83	32·37	25·16	28·54
Moisture	14·11	10·88	12·62	20·67	10·00
Ash	13·16	8·08	10·11	14·86	16·86
Sulphur	1·97	0·65	1·07	0·67	0·76
Calorific value, calories	5,669	4,973	5,347	4,681	5,311

Abeokuta District

The extent of the lignite deposits under the Benin Sands must remain a matter for conjecture until the area over which this formation occurs has been thoroughly tested by boring. The lignite is met with again about 200 miles farther west, in latitude 7° 1′ N., longitude 3° 20′ E., on the left bank of the river Ogun, in the district of Abeokuta, just to the north of the village of Moroko (Muroko), which lies to the south-west of the town of Oba (Awba) and about 10 miles south of Abeokuta town. At this point the river has cut, on its left bank, a high vertical cliff in a ridge raised above the surrounding country. The upper portion of the cliff consists of red sandy beds, and at the foot of these is a shelf, covered by water except in the dry

season, containing the following in descending succession, overlain unconformably by the Benin Sands :

	Ft.	In.
Grey, sandy clay, carbonaceous at the top	7	9
Red and yellow sand		10
Brown carbonaceous shale	2	11
Lignite	2	3
Grey carbonaceous shale with plant remains; micaceous towards the bottom.	1	1
Base not seen.		

The Moroko lignite is distinctly laminated, and has a somewhat earthy appearance. It contains laminæ or irregular fragments of charred, pulverulent material, which is believed to represent decomposed vegetation transported before deposition. No attempt has been made to determine the lateral extension of the seam or the thickness and contents of the Lignite Series below the beds which have been enumerated.

The country to the south of Abeokuta is described in *Bulletin No.* 2, 1922, of the Geological Survey of Nigeria, and details are given of a number of sections in streams and railway cuttings. The occurrence of lignite, however, is nowhere recorded although the Moroko cliff section was one of those visited.

Examination of a representative sample of Moroko lignite carried out at the Imperial Institute gave :

	Per cent.
Volatile matter	30·50
Fixed carbon	42·83
Moisture	9·44
Ash	11·17
Calorific value, calories	5,857

These results show that the Moroko lignite, in spite of its earthy appearance, is somewhat superior in quality to that from the Asaba District (p. 329).

Benin City District

A sample stated to have come from near Ohe, Benin City district, within seven miles of a river navigable by canoes, and to occur in seams varying from 18 in. to 8 ft. thick, has been examined at the Imperial Institute. The sample, which was sent by a Forestry Officer, consisted of pieces of brown lignified wood which appeared black and

lustrous on a freshly fractured surface. It ignited with difficulty, burnt like charcoal, and was probably not a true brown coal. Analysis gave :

	Per cent.
Volatile matter	37·40
Fixed carbon	41·29
Moisture	20·31
Ash	1·00
Calorific value, calories	5,134

Other Occurrences

Lignite has been reported by natives from Agbor, Onicha Olona, Ogwashi, and other districts in the Benin province, but as these localities have not yet been inspected by competent authorities it is impossible to give particulars of the alleged occurrences at present.

Utilisation of Nigerian Lignite

The use of lignite as a fuel presents several difficulties to the engineer accustomed to coal, by reason of the fact that it is lighter than coal and has a lower heating value, and in burning produces more flame and tends to disintegrate, with the result that unburnt particles are liable to pass into the flues. Lignite does not " cake " like bituminous coal, and its ash being bulky and pulverulent, is apt to choke the fire-boxes. Lignite requires greater storage accommodation than coal and as it dries by exposure to the air, it tends to break up, producing much " smalls " and dust.

The utilisation of lignite as fuel both in the manufacturing and transport industries has received considerable attention in Germany and Bohemia, and methods similar to those employed in these countries would probably have to be applied in Nigeria if the lignite deposits of the Colony are to be utilised. Bohemian lignite, which is a hard variety similar to Okpanam lignite, is mined on a very large scale and transported to the manufacturing towns of Central Germany, where it is used as fuel for locomotives, steamboats and many important industries. It becomes of interest therefore to compare the lignites of Germany and Bohemia with those of Okpanam and Newi.

For this purpose the following table has been compiled in which analyses of certain British coals are also included :

	Volatile Matter.	Fixed Carbon.	Moisture.	Ash.		Calorific Value.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Calories.*
Typical British Coals.						
1. Glamorganshire	10·4	86·4	—	3·2	0·62	8,444
2. Staffordshire	34·5	62·7	—	2·8	1·33	7,978
3. Lancashire	32·6	59·9	—	7·5	0·62	7,552
4. Scotch	35·84	53·7	9·09	1·2	—	7,590
5. Patent fuel.	17·5	—	1·45	9·0	—	7,675
Nigerian lignite :						
Average Okpanam	47·43	31·60	12·36	8·80	1·39	5,820
Average Newi.	44·91	32·37	12·62	10·11	1·07	5,357
German lignite :						
Breunsdorf	43·36	18·09	31·02	5·53	2·60	4,822
Bohemian lignite :						
Aussig	36·72	38·60	22·22	2·46	0·69	5,603

It will be seen from these analyses that the Okpanam lignite is of better quality than that from Newi, whilst if dried to the same degree there would be little to choose between the Okpanam, Aussig, and Breunsdorf lignites.

It has been pointed out already that Nigerian lignite, as mined, contains much moisture, but on exposure to air this is rapidly reduced to a comparatively small amount and consequently does not seriously affect the use of the lignite as a fuel. The relatively large proportion of volatile matter to fixed carbon in lignite, however, causes the material to burn more rapidly and to produce more flame than steam coal.

These difficulties can be overcome to a large extent by briquetting the material before use, and this treatment has the advantage not only of increasing the density and calorific value of the fuel but also of rendering it practically impervious to moisture and of eliminating the tendency to disintegrate, either when stored or during firing.

Briquetting Trials

Practical firing trials with the crude lignite carried out in Nigeria gave satisfactory results in many cases, but in some instances, probably through lack of experience in using this fuel or the unsuitability of the fire-boxes, the preliminary results obtained were not altogether satisfactory, and this emphasised the necessity of ascertaining

whether the Nigerian lignite could, by briquetting, be brought somewhat nearer to coal in firing quality, since if this could be accomplished changes in methods of use and in the construction of the fire-boxes would be largely avoided. A thorough investigation of briquetting methods for lignite was therefore carried out by the Imperial Institute, and trials of two systems of briquetting were made with large consignments of the Okpanam and Newi lignites.

The greatest improvement effected by briquetting lignite is usually in the physical condition of the fuel, but its heating power is also raised, as shown in the following analyses made at the Imperial Institute on German lignite obtained for comparative trials :

	Crude Breunsdorf lignite.	Household briquettes made from Breunsdorf lignite.
	Per cent.	*Per cent.*
Volatile matter	45·36	48·28
Fixed carbon	18·09	28·59
Moisture	31·02	15·67
Ash	5·53	7·46
Sulphur	2·60	3·29
Calorific value, calories	4,822	5,575

This sample of crude Breunsdorf lignite had dried somewhat in transit to London, and in place of the 50 per cent. of moisture found in the freshly extracted material only 31 per cent. was present, so that the improvement of the crude material due to briquetting is really much greater than is shown by the foregoing results. These results are sufficient to show, however, that briquetting causes a great reduction of moisture, an increase in the ratio of fixed carbon to volatile matter and an increase in the calorific value.

Three general systems of briquetting lignite are in use. In the simplest of these the wet lignite, as it comes from the mine, is disintegrated and then pressed by auger machines into bands which are cut by wire-cutters into brick-shaped masses. Such briquettes are produced in Germany from powdery wet lignite, but this system is not applicable to the hard lignites of Nigeria and Bohemia.

The British system used for briquetting coal dust with a binder can in some cases be used for lignite. This con-

sists of mixing the roughly ground lignite with coal tar pitch, asphalt, wood pitch or other suitable binder and then compressing the mixture. It was by this system that the English "patent fuel" formerly used on the Nigerian railways was manufactured from coal dust. For success in the process, however, it is essential that the coal or lignite should be of such a character that it will absorb a suitable quantity of the binder, which should be obtainable at a reasonable price.

The third system is one extensively used in the Rhine Province and Central Germany. The lignite is first ground to a coarse powder, dried, and finally compressed under high pressure whereby the lignite undergoes partial decomposition with the liberation of a certain quantity of bituminous material, which serves as a binder.

When the preliminary trials on Nigerian lignite were made it was difficult to find a firm in the United Kingdom who had had experience in the manufacture of plant for briquetting lignite. One firm, however, which had made lignite briquetting machinery, claimed that the system they advocated had the advantage that the high pressure, developed at the moment of compression, had the effect of reducing to a minimum the quantity of pitch required as a binder. The material used for trial with this process consisted of 16 cwts. of lignite collected in the Atakpo Valley. The lignite was broken and divided into three portions, which were treated with 8, 7 and 5 per cent. of coal tar pitch respectively. In every case it was not found possible to obtain thorough admixture of the pitch and the lignite in the heater, and the trial had to be abandoned.

Other firms in the United Kingdom interested in peat briquetting machinery were also consulted in order to ascertain whether such plant could be adapted to treating lignite, but without success.[1]

Enquiries were then made on the Continent, where the briquetting of pulverulent lignite had received much

[1] Since the above trials were made, several firms in the United Kingdom have devoted attention to the briquetting of lignite and are now in a position to supply plant for the purpose, suitable for use with or without a binder. One firm has produced excellent briquettes from Nigerian lignite without the aid of a binder.

attention, and two factories were visited by representatives of the Imperial Institute. The first firm consulted were makers of briquetting plant for all three types of process mentioned above, and samples of Okpanam and Newi lignite were forwarded for trial. They reported that neither of them was suitable for briquetting, either with or without added pitch. They added that both the lignites were very porous and would absorb so much pitch as to render the process uneconomical. Small consignments of the Okpanam and Newi lignites were sent to a second firm to be treated in a small experimental plant at their works. Very promising results were obtained, and on analysis the briquettes produced gave the results shown in the following table, to which are added for comparison results afforded by the lignites from which they were made :

	Okpanam lignite.	Briquette made from Okpanam lignite.	Newi lignite.	Briquette made from Newi lignite.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Volatile matter	51·45	53·57	48·17	46·97
Fixed carbon	32·93	33·66	29·83	30·88
Moisture	9·70	7·22	10·88	10·20
Ash	5·92	5·55	11·12	11·95
Sulphur	0·85	—	1·08	—
Calorific value, calories	6,368	6,494	5,669	5,769

The firm suggested that as the trials had so far proved satisfactory a large-scale trial should be carried out with the Nigerian lignite at a works equipped with their plant.

The proprietors of a briquette factory at Breunsdorf, near Kieritsch in Saxony, kindly gave permission for their works to be used for the trial, which was attended by a representative of the Imperial Institute. A brief account of the operation of this plant may be of interest.

The raw lignite is brought by means of lifts to the top of the briquetting factory and tipped into the hopper which feeds the crushing rolls. From these the ground lignite passes into a sieve, which separates the coarse, hard, and fibrous matter. This is reground and again sifted, and any lignite rejected by the sieve at this stage is burnt under the boilers.

The ground and sifted lignite is next conveyed to the driers. These are of two kinds (1) rotating steam-heated

plates on which the lignite is continuously re-spread by arms carrying scrapers, and (2) the Schulz tubular pattern. The latter consists essentially of a tubular drum which is set at an angle of about 7° with the ground and rotates slowly on two trunnions. The tubes into which the lignite is fed run lengthwise, are about 4 in. in diameter and are externally heated by steam. As the tubes rotate the lignite falls from the lower ends, its moisture content having been reduced from about 50 per cent. to about 18 or 20 per cent. It has been found in practice that this hot lignite as it leaves the driers requires to be cooled before being pressed. From the cooling apparatus the lignite is conveyed by a belt to the second floor and is distributed to the hoppers feeding the briquette presses.

The die for shaping the briquettes is an open tube which gradually contracts towards its outlet to the size and shape of the briquette to be made. The press plunger fits accurately into the upper larger end of the die and at every stroke it drives the contents of the die forward, resulting in the development of about 1,500 atmospheres pressure. At each stroke a briquette is formed and is pushed out at the contracted end of the die on to long narrow rails, which run down to waggons and are often of considerable length. The briquettes are hard, compact, and lustrous, are not affected by rain, and will stand a considerable amount of rough usage without fracture. The presses vary in capacity from 40 to 90 tons of briquettes per day of 24 hours, but 50 tons per day may be taken as an average output.

The briquettes vary somewhat in shape according to the purpose to which they are to be applied. For industrial use the usual form is rectangular in section and measures approximately $2\frac{1}{2} \times 2\frac{1}{2} \times 1$ in.

The large-scale trial was made with a consignment of 10 tons of Nigerian lignite, which, as received in London, contained 28 per cent. of moisture; it was therefore decided to pass it through the driers before pressing. By suitable adjustment of the press, hard, dense, lustrous briquettes of excellent quality were obtained, which were in every respect as good in appearance and physical structure as the ordinary German lignite briquettes of commerce. A

large proportion of the lignite was used in experimental runs of the plant in order to determine the best conditions for working, but eventually about 1½ tons of good quality briquettes were made and sent to the Imperial Institute. In the following table are shown analyses of the ground Okpanam lignite and briquettes made therefrom, together with those of briquettes made from some German lignites.

	Ground Okpanam lignite.	Briquettes made from Okpanam lignite.	Breunsdorf lignite briquettes.	Frecken lignite briquettes.	Rhenish lignite briquettes.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Volatile matter . .	42·36	53·80	48·28	41·82	43·34
Fixed carbon . .	25·84	33·35	28·59	37·90	35·56
Moisture . . .	27·42	7·14	15·67	15·45	15·24
Ash . . .	4·38	5·71	7·46	4·83	5·86
Sulphur . . .	0·47	0·67	3·29	0·84	—
Calorific value, calories	5,018	6,522	5,575	5,157	5,019

It will be seen from these figures that the briquettes made from Okpanam lignite are of higher calorific value than those made from German lignite, and therefore there should be no difficulty in using them as fuel for industrial purposes.

It has been pointed out already that all the Nigerian lignites differ considerably from typical German lignite both in structure and in hardness, and the trials showed the necessity for certain modifications in the Buckau machinery, as used at the Breunsdorf factory. As the Nigerian lignite during grinding produces much dust, which is unpleasant to breathe and is liable to cause explosions, an enclosed type of grinding mill would have to be used. As has been already indicated, the Nigerian lignite contains less moisture than German lignite, and in the dry season at least could be deprived of a considerable proportion of its water by exposure to air; only one drying drum therefore would be necessary to keep each press supplied with dry lignite, instead of a pair, which is sometimes necessary.

A British firm who have briquetted Nigerian lignite successfully by a process similar to that described above can now supply a plant capable of drying and briquetting 100 tons of lignite per day at a cost of about £10,000 (December 1922).

Firing Trials with Lignite Briquettes in Nigeria

It was hoped that it would be possible to arrange for the production at Breunsdorf of enough briquettes from Okpanam lignite to permit of extended firing trials being made in the Northern and Southern Provinces of Nigeria; but this was found impossible as the factory could not spare the time necessary for a further briquetting trial. It was therefore arranged that the 1½ tons of Okpanam lignite briquettes which had been produced should be sent to Nigeria for trial on the Baro-Kano railway, and that 20 tons of German lignite briquettes of similar quality should also be obtained and sent out for other firing trials on steamboats and railway locomotives in Nigeria.

The following are the results of the examination of the two sets of briquettes sent out to Nigeria for these trials:

	German lignite briquettes. *Per cent.*	Okpanam lignite briquettes. *Per cent.*
Volatile matter	46·29	53·80
Fixed carbon	35·94	33·35
Moisture	12·76	7·14
Ash	5·01	5·71
Sulphur	0·42	0·67
Calorific value, calories	5,185	6,522

It will be seen that the German briquettes were inferior in calorific value to those made from the Okpanam lignite.

Reports on the firing trials made with these briquettes in the Northern and Southern Provinces of Nigeria are summarised below.

Locomotive Trials.—In the trials carried out in the Southern Provinces the lignite briquettes were found to burn freely with a good heat, and no trouble was experienced in maintaining a good pressure of steam whilst running. The only objectionable features noticed were (1) over-heating of the ash pan, (2) the production of a sandy ash, which tended to work into the mechanism of the engine and so cause over-heating of bearings, and (3) the shape of the briquettes, which proved awkward in stoking and rendered it necessary to stoke more frequently than with imported coal. On the whole, however, the Locomotive Superintendent was satisfied that such lignite bri-

quettes were promising as a fuel for locomotives. It was suggested that over-heating of the ash pan could probably be prevented by the use of closer-fitting fire bars in the fire-boxes.

The sandy ash mentioned above is peculiar to the German briquettes, but the ash from the Okpanam lignite briquettes is of a different character, being soft and powdery, and is therefore not likely to cause trouble of the nature indicated above.

As regards shape, the German briquettes referred to above were of the " double hammer-head " pattern, but in briquetting Okpanam lignite in Nigeria smaller briquettes, rectangular in section, could be produced, and the difficulty in stoking thus avoided.

In the Northern Provinces during the course of the locomotive trials no difficulty was experienced when using either German or Nigerian lignite briquettes as fuel. They were considered to be easy to handle and clean in firing, and a good pressure of steam could be maintained. Practically the only objection raised against this form of fuel was that it had a lower calorific value than the patent fuel then used on the railways in the Northern Provinces, and consequently much more was consumed. The difference, however, between the two fuels in this respect would be much less in practice if grates suitable for burning lignite were fitted to the locomotives.

The results obtained in the Northern and Southern Provinces of Nigeria in the locomotive trials are compared below :

Northern Provinces.	German[1] *Trial A.*	German[1] *Trial B.*	Nigerian.[2]
	lb.	*lb.*	*lb.*
Consumption of lignite briquettes, per mile .	49·4	71·48	65·88
Consumption of patent fuel, per mile . .	14·8	47·31	25·65
Ratio of lignite briquette consumption to coal consumption	3·3 : 1	1·5 : 1	2·6 : 1

[1] *German lignite briquettes used.*
[2] *Okpanam lignite briquettes used.*

Southern Provinces.	*Per engine mile.*	*Per train mile.*
	lb.	*lb.*
Consumption of German lignite briquettes . . .	60·8	63·4
Consumption of coal	32·2	40·2
Ratio of lignite briquette consumption to coal consumption	1·8 : 1	1·6 : 1

It is clear from these figures that nearly the full fuel

value of the German lignite briquettes in comparison with imported coal was realised in the locomotive trials made in the Southern Provinces, but that this was far from being the case in those carried out in the Northern Provinces except as regards trial B. This failure to obtain the full heating power of the lignite briquettes was probably due to inexperience with this kind of fuel since all the trials were carried out on the same locomotive and satisfactory results were secured in trial B.

Marine Trials.—In trials made in the Southern Provinces in a steam launch running under ordinary conditions, the consumption of lignite briquettes was 446 lb. per hour as against 342 lb. per hour for Welsh coal.

In these trials, as in those on locomotives in the Southern Provinces of Nigeria, practically the full fuel value of the lignite briquettes in comparison with Welsh coal was realised and there appears to have been no difficulty in maintaining steam.

The results of these trials of lignite briquettes on railways and steamboats in Nigeria are on the whole satisfactory in showing that the fuel can be used in place of coal. Under the best conditions of firing Okpanam lignite briquettes will be about 30 per cent. less efficient as a fuel than imported Welsh coal.

Low Temperature Distillation of Lignite and Preliminary Heat Treatment

So far the consideration of the possibilities for utilising raw or briquetted Nigerian lignite has been limited to its employment as a fuel for railways and steamboats, but there are numerous other uses of industrial importance. Thus, unbriquetted lignite is used in Europe as a fuel for producer gas engines, for the manufacture of illuminating gas and for firing pottery and cement kilns. When lignite is used in producer gas plant an important quantity of sulphate of ammonia is often recovered as a by-product.

Recently attention has been directed towards the possibilities of treating fuel, (1) by low temperature distillation, and (2) by increasing the fuel value by means of a preliminary heat treatment.

Experiments have been carried out on Nigerian lignite with both of these processes, the results of which are briefly summarised below.

A sample of partly air-dried Nigerian lignite, containing about 12 per cent. of moisture, was subjected to low temperature distillation in an internally heated retort at temperatures of 600° C. and 650° C. The work was carried out by a firm which specialises in the construction of plant for this purpose, and the following results were obtained :

	Distillation at 600° C. *per ton.*	Distillation at 650° C. *per ton.*
Tar	22 gallons	13 gallons
Light oils	6·6 „	7·4 „
Gas	5,750 cubic feet	7,960 cubic feet
Sulphate of ammonia	10 lb.	19 lb.
Coke	9·2 cwts.	9·0 cwts.

The gas had a calorific value of about 850 British Thermal Units per cubic foot.

The "coke" ignited readily and that produced by the distillation at 600° C. had the following composition :

	Per cent.
Volatile matter	5·00
Fixed carbon	78·25
Ash	16·75
Sulphur	1·52
Calorific value, calories	6,670

The light oils after purification could be used as motor spirit, and the tar, when dehydrated, would be suitable for use as a fuel oil.

The cost of a plant for treating 100 tons of lignite per day by the above process would be about £50,000 in the United Kingdom (December 1922).

The process for increasing the fuel value of lignite by means of a preliminary heat treatment is based on the fact that raw lignite contains a considerable percentage of moisture which can be driven off by heating the fuel to 100° C, whilst on further heating to a temperature of 300–400° C. reaction occurs between the constituents of the material with the evolution of a further quantity of steam and some carbon dioxide.

A sample of Nigerian lignite treated in this manner by the firm referred to above gave a solid product amount-

ing to 80 per cent. of the original material, about 1,000 cubic feet of a gas of no value for heating purposes, and about 7 gallons of tar.

The solid residue gave the following results on analysis :

	Per cent.
Volatile matter	47·55
Fixed carbon	42·75
Ash	9·70
Sulphur	0·85
Calorific value, calories	6,300

Nigerian lignite under this treatment gives a larger quantity of tar than is obtainable under the same conditions from coal. The treated lignite would be a much better fuel for boilers than the untreated material owing to its higher calorific value, the higher temperature obtainable, and the fact that it burns more rapidly. The treated lignite also has less tendency to absorb moisture than has air-dried raw lignite.

Conclusions

It will be seen from the foregoing results that the investigations carried out by the Mineral Survey of Southern Nigeria under the auspices of the Imperial Institute resulted in the discovery of large deposits of lignite spread over a considerable area. Some of them, such as those on both sides of the river Niger near Asaba, are favourably situated for transport. A careful study of the lignite in the laboratories of the Institute showed that it was of satisfactory composition and good calorific value, whilst the practical trials undertaken by briquette manufacturers in Germany, and attended by representatives of the Imperial Institute, proved that the lignite is quite suitable for briquetting. Firing trials with the briquettes in railway engines and steamboats in Nigeria have indicated that they can be used quite satisfactorily as fuel for industrial purposes.

THE TREES OF THE GOLD COAST

THE first systematic account of the forests of the Gold Coast was the *Report on Forests of the Gold Coast*, by H. N.

Thompson, Conservator of Forests, Nigeria, issued in the Miscellaneous Series of Colonial Office Reports (No. 66, 1910). This valuable work is now unfortunately out of print, but its place is filled to some extent by the recently published *Forest Officers' Handbook of the Gold Coast, Ashanti and the Northern Territories*, by T. F. Chipp, M.C., B.Sc., F.L.S., which, however, deals with the subject on somewhat different lines (cf. review on p. 412). Both these works are of a technical nature. A more general account of some aspects of the Gold Coast forests is given in the following article, which is based on information supplied by Dr. J. M. Dalziel, M.D., B.Sc., F.L.S. Dr. Dalziel, who joined the West African Medical Service in 1905 and is now Senior Sanitary Officer in the Gold Coast, has devoted much attention to the study of West African vegetation; his *Hausa Botanical Vocabulary* was reviewed in this BULLETIN (1917, **15**, 145).

The forests of the Gold Coast are not to be viewed with advantage from the deck of a ship, nor do the trees typical of the country lend themselves to observation at most of the seaports. Only at Axim and westward, does the true evergreen forest, which stretches in a broad irregular belt from the eastern railway to the western boundary of the country, reach the coastline.

The traveller who passes from Seccondee to Coomassie by rail, and thence to North Ashanti and the Northern Territories, either by motor or on foot, will traverse numerous belts of forest of varying degrees of verdure. In the present article it is proposed to describe some of the trees and plant associations which may be observed on the journey.

For a few miles from Seccondee the vegetation is little more than open savannah, repeatedly cleared for farming, and evergreen in patches with weeds and unkempt shrubs, amongst which coarse grass is not absent. This again passes into a semi-evergreen forest with much irregular undergrowth and many trees, which lose their leaves in the dry season. Even here, however, tall pale stems of noble trees left throughout several rotations of farm clearing attest some at least of the types of the original forest. The silk-cotton tree is prominent everywhere,

but the "odum" and others mentioned later are also conspicuous against a background of tangled greenery.

At about ten or twelve miles along the road a truly evergreen high forest is reached, which continues all the way past Tarkwa as far as Imbraim or even Dunkwa.

As regards the constituents of these varieties of forest, it may be said at once that mahoganies are scarcely in evidence at this stage. The silk-cotton tree (*Eriodendron orientale* = *E. anfractuosum*) is ubiquitous, a denizen of all types of West African forest, and, though always a giant, it attains its maximum growth in some of the Ashanti forests. A marked characteristic is the heavy buttressing of the stem (Pl. I, fig. 1) and even some of the older limbs high up on the tree are bracketed to the trunk in a similar way. It is deciduous, but even in January and February one may see side by side trees divested of leaves and covered with flossy balls of bursting pods, which fleck the air and whiten the ground, and trees in full foliage perhaps still with a few hanging lamp-like white blossoms.

There are two varieties of the tree, one unarmed and the other studded with short, stout spines, the former yielding a whiter floss than the latter. This floss is the article of commerce called kapok, used for stuffing cushions, etc., and for marine life-saving appliances (cf. this BULLETIN, 1905, **3**, 223), whilst an oil is obtained from the seeds entangled in it. A botanist would call the shape of the leaves digitate, of which the familiar horse-chestnut may be cited as an example. The wood, light and soft, is used for canoes where more durable timber is lacking, and the wide plant buttresses are cut off to make native doors, plates, and wooden slabs used by cloth dyers.

The tree known in the Gold Coast as "odum" and in Nigeria as "irokọ" (*Chlorophora excelsa*) is sometimes regarded as the best all-round timber tree in West Africa. It is variously named African oak, African teak, and rock elm (from the obliquely-shaped leaf resembling, though larger than, that of the European elm). The bole alone may reach 80 or 90 feet, with pale bark, few main branches, and commonly an umbrella-shaped crown but without dense foliage. The buttresses do not reach far up the

PLATE I.—THE TREES OF THE GOLD COAST

FIG. 1. Clearing on edge of semi-deciduous forest. *Eriodendron orientale*, the silk cotton or kapok tree, to the left.

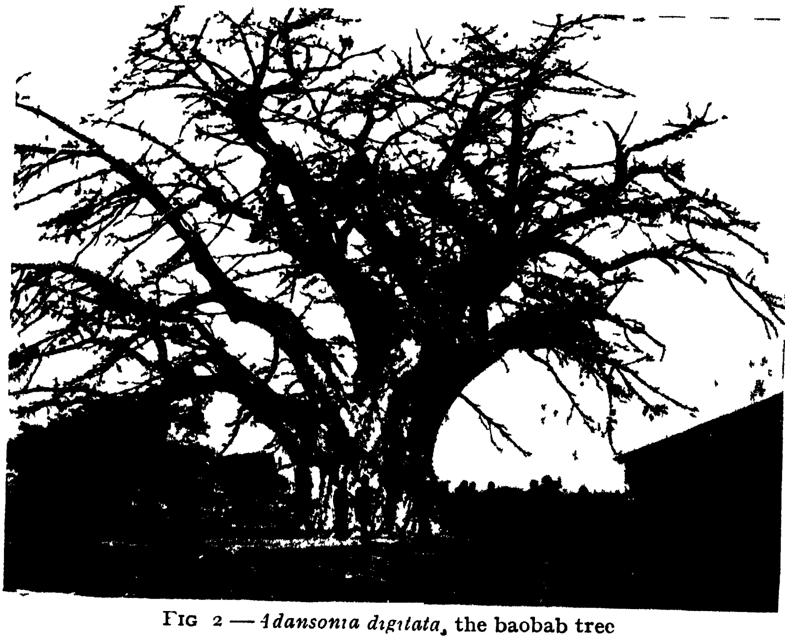


FIG. 2.—*Adansonia digitata*, the baobab tree.

stem. Flowers appear in catkins, male and female on different trees, and the timber, too heavy to float when fresh, resists white ants and darkens on exposure. It is probably the best wood for railway sleepers, and some splendid canoes and fine articles of heavy furniture have been made of it. The odum occurs both in clearings and in forest along with mahoganies and cedars, e.g. in South and West Ashanti, and on the steep hills around Obuasi.

Another very common tree which meets the eye without proceeding farther up the line is the "waw-waw" (*Triplochiton Johnsoni*). It may be called "African maple," and is easily recognised from the shape of the leaf, which is shaped like that of the maple and five-lobed. This is a lofty, straight-stemmed tree, very abundant on cleared areas, and often showing splashes of yellowish colour on comparatively smooth pale bark. The stem of this species also is moderately buttressed at the base. The bark is used by the natives for roofing, and the wood is considered of value for interior house work, but is not white-ant proof. A report on the timber of this tree from Nigeria was published in this BULLETIN (1913, **11**, 84). Petals of white and red may be found as wind-falls, but the flowers, though fairly conspicuous, are generally inaccessible on the tree.

The last-named is one of the less valuable timber trees, and in the same category we may place one or two others whose first acquaintance can suitably be made in the same company on railway clearings or abandoned farms. Of these the "dahomah" (*Piptadenia africana*), a kind of African greenheart, is one of the most abundant in the Ashanti forests of both evergreen and half deciduous types. This tree grows to over 100 feet, with a straight bole of 80 feet or more, buttressed at the base, and its chief characteristic is the thin feathery crown with wide-spreading flat sheets of finely cut fern-like leaves. The pod is also characteristic, being about a foot long and one inch wide, but containing only 6–8 seeds, which are perfectly flat, each surrounded by a brown-tinted wing of long, oval shape. The heartwood is brown and durable, and nearly termite-proof. Canoes and railway sleepers have been

made from this timber and it can be used for house-building. This ornamental tree can be observed at Coomassie, where several typical specimens have been left in position on the cleared area, and from any of the bungalows on the Residential Ridge the tall smooth stems of the Piptadenias at the margins of the yet uncleared bush with their filicoid foliage showing up fretted against the sky form a characteristic and delightful picture.

The trees which are used for roof shingles belong mostly to the genus *Terminalia*, and are found abundantly and of dominant stature in the same forests as the above. Their native names are " affram " (*T. superba*), " emire " or " emril " (*Terminalia* of perhaps several species), and in their younger stages are quickly recognised by a character which can be studied without leaving Accra by observing their broad-leaved congener the Indian almond tree (*T. Catappa*) which lines the streets. This character is the slender, perfectly straight pole with interrupted pagoda-like tiers of branches spreading horizontally in circles like the trays of a cake-basket. The shingle-wood trees of the forest have smaller leaves than *T. Catappa*, and some of them are buttressed at the base of the stem. In the full-grown tree the whorled branching may be obscured by foliage or natural accidents.

The species described above as types are prominent in the northern forests and meet the eye of the traveller because they have either been left as " standards " when the clearing was made, or because they have properties which give them an advantage in such situations, e.g. the waw-waw has a heavy seed which will fall to the ground even through dense leafy undergrowth, while some proportion of the winged seeds of the *Piptadenia* and *Terminalia* will always reach the earth. On the other hand the tangled lower layer of weeds and scrambling shrubs would choke their growth if they did not possess the power of vigorous growth as seedlings.

These trees may be regarded as descendants from the original primeval forest, but on the same cleared areas will be seen the umbrella tree or cork-wood (*Musanga Smithii*), which was probably not a member of the original association. This somewhat grotesque evergreen

is the first to spring up on old farms, and it serves to protect the exposed soil from the fierce sun, forms leaf-mould and so allows the more robust species to regain a footing. It may be rightly objected that, if the original forest contained mahogany and cedar, this luxuriant weed delays the regeneration of the most useful economic species, and favours the growth of the less valuable timbers. Its appearance is unmistakable, with every leaf a parasol, and with its stem supported at the base (usually invisible amongst tangled undergrowth) by aerial stilt-like prop roots. The wood, of very rapid growth, is soft and is used like cork for nets on the Axim coast, and on a larger scale to float mahogany logs. Other uses of the wood are for knife and sword scabbards, for cigar-boxes and shingles, whilst it is also suitable for the manufacture of paper pulp (this BULLETIN, 1921, **19**, 10).

As one passes northwards to the Offin River at Dunkwa, across into Ashanti, the proportion of trees which periodically shed their leaves increases. Mahogany and cedar, the former evergreen and the latter deciduous, will now be seen on the steep forest hills along with *Piptadenia*, shinglewood, and others. The mahoganies belong to several species of *Khaya*, and the African cedars to the genus *Pseudocedrela*, both of the same Natural Order (Meliaceæ). The leaves of both are pinnate, and in the former the leaflets are often fairly large. The mahoganies have brown fruit capsules, which are almost spherical, while those of the cedars are elongated, and in both cases the fruit splits open from above downwards in 5 or 4 valves which generally remain empty on the tree. The seeds are flat, winged and numerous, and tightly compressed in the pod. One species of *Khaya* (the " dubini ") and two of *Pseudocedrela* are typical of the moist rain forest, but the others are more frequent in forests with a mixture of deciduous trees. Their chief home is, perhaps, in South and West Ashanti along with the native rubber tree, *Funtumia elastica*; but a visit to the sacred Lake Bosumtwi will afford a sight of both mahogany and cedar luxuriant on the slopes above the shore.

During the drier months even in the evergreen forest, a brilliant object contrasts with the verdure in the form

of a leafless tree covered with rather large crimson flowers. This is the red-flowered silk-cotton tree (*Bombax buonopozense*), a large tree with a whorled arrangement of branches and bark strongly set with stout spiny protuberances. The rich, red, tulip-like flowers attract bats and, when fallen, are sometimes sought by antelopes, and the floss from the pods is a minor forest product like the true kapok.

Some objects of lesser importance, but sufficient to excite the curiosity of the traveller, may now be mentioned. Often one sees a comparatively small tree which puts forth its young shiny leaves of a bright red colour. (In lesser degree the young leaf of the cocoa has the same peculiarity.) This is the crab-wood (*Carapa procera*), a sort of cedar mahogany, and it may be found up to North Ashanti in those evergreen belts which are called fringing forests. Its leaflets are larger than those of the largest mahogany, and the fruit is a rough-shelled capsule, which falls and bursts in about 8 valves, releasing 20 or more large brown seeds with rounded edges, but flattened sides. From these is extracted an oil (carapa or crab oil) which is used with ashes from burnt plantain skins to make native soap (cf. this BULLETIN, 1908, **6**, 360).

Another peculiar tree looks in its sapling state like a loose-leaved cabbage on a pole. Some call it a cabbage palm, but it is not a palm. The mature tree has a few tall raking branches each with its terminal cluster of broad leaves. The wood is sufficiently soft for the stem to be hollowed out for quivers, and its scientific name is *Anthocleista* (*A. nobilis* and *A. magnifica*).

The tree from which most of the Ashanti stools are made (*Alstonia congensis*, the pattern or stool-wood tree) will be seen now and then from the railway, in the moister parts of the forest, often in the company of thickets of climbing palms. Like the shingle tree the branches are in whorls, but, being evergreen with heavy glossy foliage and forming a flat umbrella crown, this is not apparent at a distance. In the same way the leaves, which look as if digitate, are really growing in rings of 7 or 8 of almost even size. If one of these be broken off there flows a stream of white latex. The wood is white, soft, and

easily carved into tops, curios and stools made in one piece from a single block ; a corresponding industry exists in Nigeria and Cameroons. The tree sometimes grows with a divided bole, and a specimen of this may be seen in the Public Works Department yard at Coomassie.

The vegetation of which a few types have been described above furnishes a continuous moving film as seen from the railway carriage, and perhaps leaves behind only the confused memory of a lofty screen of tangled greenery contrasting with the tall pale pillars of the odum, the silk-cotton and other dominant trees. Or it may be that in some swampy areas near the track the feathery thickets of the climbing *Calamus*, or rattan, with its long, whip-like unfolded leaf, or its slender tapering fronds beset with reflexed hooks, mingled with gigantic plumes of the bamboo palm, excite our wonder. This uncontrolled growth of vegetation is sometimes regarded as virgin forest, but as a matter of fact the forest that meets the eye in these regions is far from primeval, and is mainly a growth secondary to man's interference.

In such forests, which in their present form are of no great age, a chief characteristic is the dense thicket of undergrowth, often impenetrable without the free use of the axe. This again keeps the soil moist, the atmosphere humid and stagnant, and a lofty lower tier of vegetation arises composed of tangled scrambling shrubs and woody twiners, the upper limbs of which are often borne aloft hanging from tree to tree, and it may be flowering very many yards away from their parent roots. These lianes belong, commonly enough, to the genera furnishing the various rubber vines, occasionally the uncultivated species of arrow-poison *Strophanthus*, while the more leafy scramblers are usually thorny Acacias and brilliant flowered Combretums.

It would certainly take many generations, probably a few centuries of freedom from occasional clearing and periodic farming, to restore to such forests the aspect of their older growth.

The true virgin forest is really one of lofty growth which, seen from above, would show a sort of ocean of foliage, by no means without crests and hollows, but free from gaps

and areas of mere jungle. Its undergrowth, though dense, is not an impenetrable tangle, but an underwood of shrubs and saplings, and the ground may be free from mouldy moisture and covered with dry fallen leaves. On some of the steep forested hills, where not already invaded for cultivation, somewhat ancient and fairly open forests are seen, and in the far west of Ashanti, by the Ivory Coast frontier, the country is said to be covered by practically virgin forest. According to Mr. H. N. Thompson, Conservator of Forests, Nigeria, a splendid example of almost primeval forest exists to the east of Lake Bosumtwi, composed of lofty trees with a dense leafy canopy, in the shade of which " the undergrowth is so sparse that one can see for 60 to 70 yards through the forest, and can walk freely about it without having to use the matchet."

Many of the large trees in the southern forests support, besides the extraneous foliage of twiners, woody climbers, and rope-like lianes, a crop of accessory vegetation which finds a habitat on the higher branches. The latter is not truly parasitic in the sense of depriving the tree of its vital juices, but it may injure the host by interfering with its life processes in other ways. When not composed of orchids, slender-leaved with hanging roots, or succulent and closely attached, these epiphytes will be found to be chiefly nests of the elk's horn fern (*Platycerium æthiopicum*).

The Brazilian Para rubber tree, as seen in the plantation beside the Offin River at Dunkwa or in the Coomassie Agricultural Station, is an exotic which has proved itself superior in yield, rapidity of growth and hardiness, to the true African rubber tree (*Funtumia elastica*). The latter, the silk-rubber tree (also called Ireh, or Lagos rubber) is still cultivated, and exists naturally, often in great numbers, in the forests where leaf-shedding trees form a fair proportion with the evergreen. In parts of South Ashanti belts of unmixed *Funtumia* occur, and in some forests where cedar and mahogany are common this indigenous rubber tree is also abundant. It has shining foliage, a light grey or almost silvery bark, and the scented flowers are in close bunches of pure white small tubes hidden amongst the leaves. The pods are short and stout, and in the dry season open out on the tree, exposing the flossed

seeds to the breeze. Each seed is a small golden spindle with a long slender shaft or beak, which is richly flossed with long silken hairs, and so brittle that it snaps off at contact with the ground or with the obstructing undergrowth of the forest. The silky pinion may continue its airy career, but the seed has reached its goal.

Two most important fruit trees in the economics of the Gold Coast are the kola and the cocoa tree. Both belong to the same Natural Order (*Sterculiaceæ*), but whereas the former is a native of our forests the latter is introduced.

The kola tree (*Cola acuminata*) thrives in shady forest, or under other trees, and is often seen near villages. It is cultivated in the east and north of Ashanti. The foliage is duller than that of the native rubber tree, and more or less like a large laurel. Frequently the branches have an untidy look, being covered with ferns and orchids. The flowers appear in clusters of white and pink in February or March, and the fruit is a large pod with the well-known flat-sided seeds or nuts, which vary from wine-red to white in colour. This tree is the mainstay of the Hausa trade, and in the northern hinterland of the whole of West Africa the virtues of the kola nut, social and dietetic, have an important influence on internal commerce and racial intercourse, from Kano to Tripoli, or to Morocco *via* Timbuktu

The cocoa tree (*Theobroma Cacao*) is a native of Trinidad and of the north-east of South America, and its introduction to West Africa was *via* Fernando Po and San Thomé. It is said that it was brought first to Mampong about the year 1879, by a native trader, an example which the Basel Mission was quick to follow. Like the kola it requires a forest climate, and the orderly plantations of small trees, nearly free from undergrowth, and bearing pods as if fortuitously attached to the stem, are familiar in the Colony and Ashanti. The strongly-veined leaves are lax and drooping, giving only light shade, and in the young state are generally brightly coloured.

If we now proceed beyond Coomassie into North Ashanti a striking and almost sudden change in the type of forest is apparent a few miles south of Ejura. The trees are now nearly all of the deciduous habit, and at mid-winter probably no evergreens will be seen, except

in the fringing belts along some perennial stream. An aeroplane view would still show something like a sea of foliage during the months of rainfall, but the spacing between the trees is unmistakable and is occupied by shrubs and herbs and, more significant still, by grass which will blaze furiously at the end of the dry season. This is the savannah forest, and, before the Volta is reached and beyond, it passes into still more open, park-like and orchard types with abundance of coarse grass.

The silk-cotton tree still remains dominant, but for links with the southern forests we look in the belts of verdant foliage along the line of some ravine. There we may find the ordeal tree or sass-wood, *Erythrophlœum guineense*, a lover of the moist fringes though not a tree of the evergreen forest. This is a large tree with vast crown, and yields a termite-proof timber good for ships, houses or bridges. The red decoction of the bark ("sassy-bark" of Sierra Leone and the Kroo coast—really a slang corruption of *saucy*) is used by primitive pagans in trial by ordeal.

In similar situations will be seen the only mahogany of the savannah forest, viz. *Khaya senegalensis*, and an ebony, *Diospyros mespiliformis*, which has a dark heart-wood and a small medlar-like fruit, very sweet and called monkey guava. Stunted specimens of this ebony, with black scaly bark and very dark green leaves, may even be seen on the arid scrub-lands behind Accra.

One of the most attractive trees in West Africa is that which is called the Yoruba "chew-stick" tree (*Anogeissus leiocarpus*). It is as graceful as the birch, with light-grey drooping foliage, and its beauties are seen to best advantage in the open park forest rather than in the situation of its optimum growth along the moist ravines. The heart-wood is a beautiful brown-black ebony, and is white-ant proof. Small yellowish flower-balls are succeeded by spherical dry scaly fruits like those of the alder. As no grass will grow beneath the tree it is beloved by the afforestation officer. The root is the "chew-stick," the bark is a much-used medicine, and tannin and gum are amongst its other products. This tree is a little difficult to grow, but it seeds well and an avenue raised from its seedlings would repay any effort.

A kind of "frankincense tree" (*Paradaniellia Oliveri* = "*Daniella thurifera*) is a common species in the open forests. It yields an oily resin wrongly called "wood-oil," which dries into a substance resembling copal and was formerly exploited as a variety of African copaiba balsam (this BULLETIN, 1908, **6**, 250; 1915, **13**, 44). It grows to timber size and in Togo the wood was used for making barrels.

In the more open park-savannah two very typical trees of economic importance are found, and either may be said in one locality or another to impress its character on the landscape. These are the shea-butter tree and the West African locust bean. The former (*Butyrospermum Parkii*) is generally a rather small tree, recognisable by its corrugated bark cut in squares and curiously suggestive of crocodile leather. The leaves are tongue-like, not unlike those of the mango, but obtuse and prominently veined; a milky juice flows out from the detached leaf. This tree alone redeems the park and orchard lands from the reproach of being of little economic value. It is in places extremely abundant, and its chief enemy, apart from rodents which eat the fallen nuts, is the annual bush fire, which stunts the tree, and also destroys the flowers which appear in white fragrant clusters early in the year. The thick bark and the habit of growing from root-suckers form its natural protection against fire. The fruit is ovoid, greenish, with a soft sweet covering to the brown chestnut-like seed. Shea-butter is a solid vegetable fat obtained from the dry kernels by bruising, boiling and then skimming off—a women's industry occupying 2 or 3 days. Its native uses are as an ointment, illuminant, and food, and doubtless some of the exported article returns to West Africa in soap and margarine, and possibly in chocolate (cf. this BULLETIN, 1912, **10**, 281).

The West African locust bean (*Parkia filicoidea*) is another representative tree which gives tone to the park savannah, and is often very abundant where the country is populated in many widely scattered hamlets. For example, at Naglogli, in the north of Togo, it forms by far the greatest proportion of the foliage in the nearer landscape. Generally of no great height, but with an umbrella crown, the leaves are of the feathery type

already seen in the Piptadenias, but much more dense. The flowers are like scarlet-headed drumsticks hanging amongst the spare foliage in the dry season, and are succeeded by clustered narrow pods about 9 inches in length. These afford food and fodder; a yellow meal around the seeds is edible, and the seeds when pounded and fermented make the black paste which is sold under the Hausa name *daudawa* (this BULLETIN, 1922, **20**, 461). These rather evil-smelling cakes and balls are a sustaining food which keeps well and on that account have served the itinerant Hausa, as the date serves the Arab, as both food and the means of barter. The bark can be used for tanning, and an extract of bark and pods forms with laterite gravel a native cement for floors, lining of wells, etc., and is capable of imparting a shine to pottery. The Hausa name for this tree is dorowa, but in the Northern Territories of the Gold Coast Europeans call it "dawa-dawa."

The scientific name of each of the two preceding trees commemorates Mungo Park, and the next to be mentioned recalls a traveller of another type, viz. Captain Bligh, the hero of the mutiny on H.M.S. *Bounty* in 1789, whose name appears in *Blighia sapida*, the Akee apple. It is a forest species, but becomes conspicuous when planted in the towns of the Northern Territories as a splendid shade tree with dense crown, beautiful about March or April, when the brilliant scarlet, bluntly triangular fruits hang in contrast with the dark heavy foliage. The Hausa calls this tree "fisa," but it is not very common in his own country, and the far-travelled trader meeting it there after knowing its dominance in the Gonja towns, Salaga, etc., calls it "Gonja kusa," i.e. "Gonja is near." The yellow fleshy mass at the base of the large black seed is edible, but under certain conditions unwholesome, and the symptoms caused by its use as food have led in fatal cases to confusion with yellow fever in the West Indies.

Perhaps the largest of the shade trees of these regions is a kind of mahogany bean called *Afzelia africana.* Ancient specimens are found in towns, with wide umbrella spread of foliage and scaly bark. The pods are characteristic, being very thick and hard, and nearly black. They burst with a loud report, dispersing afar the hard, shining

black seeds, which are recognisable by the fleshy base (called an aril) of orange-yellow. All over Africa such seeds are worn as a charm against weapons of war, or prepared as an inspiring potion for those about to fight, for the primitive mind, thus fortified, imagines the enemy scattered with the same vigour as that which discharges the seed. The wood, which is shipped as African mahogany, is durable, and often handsomely figured, useful for furniture, houses, bridges, railway sleepers, and native drums and mortars. Its Gold Coast name is " opapao " and in Hausa " kawo."

The baobab (*Adansonia digitata*) is a characteristic object in the open country of the north, and specimens may also be seen in the arid hinterland near Accra (Pl. I, fig. 2). Groups of them met with in the bush indicate sites of former villages. When covered with leaves, which are digitate like those of the kapok tree, it is not unlike a stunted specimen of the latter, but it is not buttressed, the bark has commonly a shiny purplish tinge, and in the leafless season the numerous pendulous fruits, long-oval and covered with a greyish furry coat, provoke the facetious fancy to a comparison with bulky rats hanging by their long tails. This fruit is the monkey bread, or sour gourd, and contains a white biscuit-like pulp of acid taste, and as the leaves also yield free tartaric acid and acid-tartrate of potash the name cream of tartar tree is deserved. The young leaves, the pulp, and the seeds pounded, steeped and fermented, are all used to flavour soup. The grotesque shape of this tree, with its stout stem and short strong branches, resembling some monstrous tuber torn from its earth, and set with roots turned upwards to the sky, is an adaptation, as in the case of the cactus, to a dry climate, the wood of the trunk being literally a vast spongy reservoir of moisture which protects the trees from death through excessive transpiration by the leaves. The largest measured by Dr. Dalziel was 40–45 feet in circumference at about breast-high from the ground, but an earlier and doubtless veracious traveller in Senegal reported one with a circumference of 112 feet. Adanson himself reckoned the age of some trees in this region to be 5,000 years, probably a miscalculation. The wood-fibre has been

exported for paper pulp (this BULLETIN, 1917, 15, 328), and the sheets of inner bark yield a useful fibre for native ropes, horse-girths, sacking and musical instruments. In the Northern Territories a black plaster for walls of huts was made from ashes of the bark.

Trees which are most commonly planted for shade in the towns of the more open country are generally of the kind popularly known as banyans. They are all fig-bearers (*Ficus*) and tend to produce aerial roots. The species are very numerous, but one of the commonest in towns has dense dark green foliage of oval leaves of no great size. At Attebubu may be seen some splendid umbrageous specimens of this variety, the scientific name of which is *Ficus Thonningii* (Pl. II, fig. 1). Another attractive species, with graceful heart-shaped shining leaves, slender-pointed, is also a good shade-giver—*Ficus syringifolia.* One with very broad leaves—*Ficus platyphylla* (which is planted along the roads in Accra)—is a species of gutta-percha tree. In the north it produces figs which are sometimes sufficiently succulent to eat, and yields a product called red Kano rubber. This species, like many others of the fig family, commonly starts life as a seedling rooted on a different tree which forms its support until in time the aerial roots strangle the host and provide a stem for itself. In the more moist Ashanti forests a rubber-yielder, *Ficus Vogelii,* with shining glossy leaves, greatly resembles the *Ficus elastica* of Brazil.

The only palm to attract the eye in the savannah forest regions is the fan palm, palmyra or deleb, unmistakable on account of its lofty crown of fan-like fronds, and its perhaps unique peculiarity of a stem tapering from above downwards like an inverted bottle (Pl. II, fig. 2). One of its names is bottle palm, and old trees sometimes show several bulgings. The fruit is smaller than the coconut, and has a smooth yellow covering which is succulent and edible. The wood is almost imperishable and white-ant proof. This palm, *Borassus flabellifer* var. *æthiopum,* may be seen in abundance on the open lands near Seccondee, and again in extensive belts in North Ashanti (e.g. as viewed from Ejura), and is really a northern species

PLATE II.—THE TREES OF THE GOLD COAST

FIG. 1.—*Ficus Thonningii.*

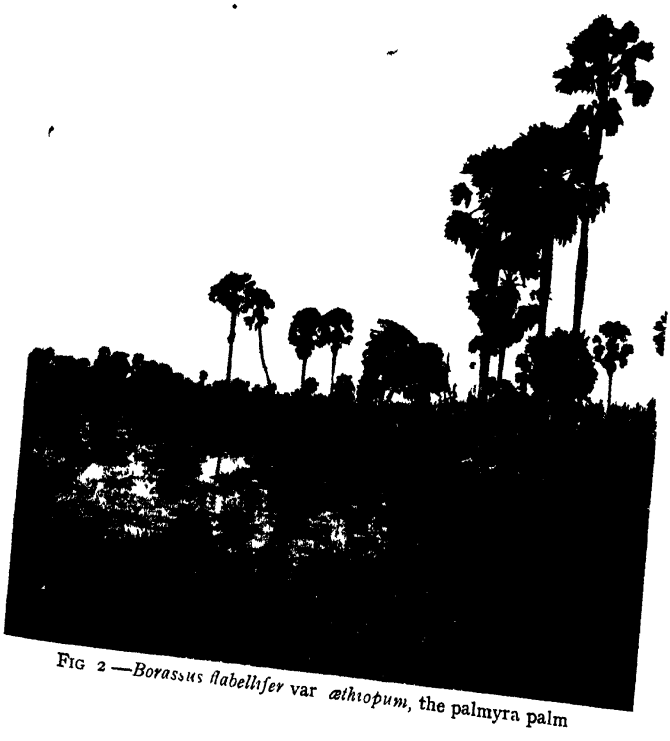


FIG. 2.—*Borassus flabellifer* var. *æthiopum*, the palmyra palm.

beyond the domain of the oil palm and the tombo or bamboo-palm (*Raphia vinifera*).

Corresponding transitions from the moist to the dry are heralded by thatch roofs instead of shingle and palm-leaf, and more fully indicated by the replacement of maize cultivation by that of guinea-corn and millet, by sweet potato for yam, and by shea-nuts and gums in place of rubber and forest timber.

The types of trees described above as found in the forests where leaf-shedding trees are in the majority are representative of what is called the Sudan zone of vegetation. From the forestry point of view these woods are perhaps regarded as of comparatively little value. On the other hand the proportion of species that yield timber fit for local use is considerable, fibre-yielders, both trees and humbler plants, are abundant, acacia and other gum trees are characteristic of the northern parts, and the rich yield of the shea-butter tree alone makes good the economic position of the savannah forests. The problems of their management are simple compared with those of the moist forests, and are mainly connected with prevention of bush-fires, which destroy tree-life and encourage the growth of mere bush and unprofitable grass.

NOTES

Imperial Institute: Committee of Inquiry.—In February of this year the Duke of Devonshire, Secretary of State for the Colonies, appointed a Committee with the following terms of reference:

In view of the withdrawal of overseas contributions and the consequent financial difficulties of the Imperial Institute, to consider and report (1) what functions at present carried on by the Imperial Institute are considered essential, and (2) whether these should be continued by the Institute or attached elsewhere, and in this connection to take into account the functions of other research organisations and to report what consequential legislative or other measures will be necessary to carry their recommendations into effect; further, to report on the functions of the Imperial Institute, and to what extent the intentions of the founders and the Royal Charter are being carried out; and to suggest any improvements which they consider financially possible, if they recommend that the Institute shall be carried on on its existing basis.

The Committee is constituted as follows: The Hon. W. Ormsby-Gore, M.P. (Chairman); the Hon. P. C. Larkin (High Commissioner for the Dominion of Canada); the Right Hon. Sir Joseph Cook, G.C.M.G. (High Commissioner for the Commonwealth of Australia); Colonel the Hon. Sir James Allen, K.C.B. (High Commissioner for the Dominion of New Zealand); the Hon. Sir Edgar Walton, K.C.M.G. (High Commissioner for the Union of South Africa); Lord Islington, G.C.M.G., D.S.O.; Sir James Stevenson, Bt., G.C.M.G. (Colonial Office); Sir Hubert Llewellyn Smith, G.C.B. (Board of Trade); Lord Kylsant, G.C.M.G.; Sir Arthur Shirley Benn, K.B.E., M.P.; Sir Gilbert Grindle, K.C.M.G., C.B. (Colonial Office); Mr. M. F. Headlam, C.B. (Treasury); Sir Edward Davson (President, Associated West Indian Chamber of Commerce); with Mr. E. B. Boyd (Colonial Office), Secretary.

The Imperial Institute and its Activities.—The following leading article was published in *The Times Imperial and Foreign Trade and Engineering Supplement* for April 28, 1923:

RESOURCES OF THE EMPIRE

When it became apparent that the Imperial Economic Conference was not to be held this spring, we urged that the Government should at once appoint a committee of business men whose charge it should be to prepare practical suggestions that might subsequently form a basis of discussion at the Conference itself. In his speech in the House, in which the President of the Board of Trade sketched the Government programme in regard to Empire development, Sir Philip Lloyd-Greame said that the resources of the Colonies and Protectorates were known, and that plans were ready to be put in force as soon as the House passed the necessary financial resolutions. We may at once confess that although we heartily welcomed the adoption of a policy which has been frequently recommended in our columns, we were considerably surprised to learn that the Government was provided with all the necessary information concerning the resources of the Colonies. Had someone at the Board of Trade found the key of Sir Auckland's box? It seemed unlikely. Where then has the information been concealed? Obviously the Imperial Institute was the proper repository, for was it not created with the very object of becoming an intelligence centre for the Empire where specimens of its multifarious products could be tested and displayed and information concerning its undeveloped resources collated? It will be remembered that at King Edward's suggestion it was built

as a memorial of Queen Victoria's Jubilee, contributions being received from loyal citizens in all parts of Her Majesty's Dominions. Starting with immense enthusiasm, the project has been allowed gradually to fade from the public mind, though its practical work for the Empire has been steadily prosecuted. Disappointment has been frequently expressed at the number of persons who visit the Imperial Institute in order to examine the remarkable and comprehensive collections of products to be seen there, though that is a common fate of permanent exhibitions which lack publicity.

It is a very shallow view to take of the importance and value of the Imperial Institute's work to judge of it solely by the number of visitors. Its real importance lies in the work done by the staff and the expert committees of which the public knows nothing. There is convincing evidence that not only the British Government, but the Governments of the Colonies and Protectorates are very far from having anything like complete knowledge concerning the value of Imperial resources, otherwise they would not send to the Institute for information. Indeed, a moment's reflection is sufficient to show that by its very nature commercial and economic intelligence is necessarily obsolescent. It must be constantly brought up-to-date, since new industries, new discoveries, new inventions, are ceaselessly bringing into the commercial arena products that only become of importance through the revelation of a need for them. Before the gas mantle was invented what was the commercial importance of monazite sand, of which the Institute has indicated new sources? So it comes about that to the Imperial Institute, Governments and firms and individuals throughout the Empire constantly resort for information. The service it renders is twofold. It examines and analyses, and ascertains the marketable potentialities of a great variety of new products; it supplies information to inquirers as to fresh sources of supply. Research work is now being prosecuted in regard to the proper preparation of raw rubber, experiments in this direction having already proved of the greatest commercial importance. Tests of tobacco grown in new territory are being made. A section is devoted to testing the breaking strain and other properties of timbers; another to testing and certifying the properties of Portland cement made from materials from new sources. There are to be seen specimens of clay sent from Central Africa, together with some bricks made from it locally, and beside them vastly better tiles and pottery experimentally made in the Institute from the same material. The practical result of all this is the creation of new industries and the

improvement of those in existence. The Mineral Section is constantly at work examining ores and deposits sent by the various Governments. At the Institute they are discovering something new every day. Meanwhile there is also a staff there engaged in collating information from all the principal technical papers and indexing cuttings from them so that on almost every subject the officer-in-charge has at his disposal the most recent and authoritative information to satisfy inquiries reaching the Institute from every quarter.

In the space available it is impossible to give more than a brief outline of the work of the Institute, but we need scarcely add that it is hampered by lack of support and the threat of suppression. That seems the normal condition of useful institutions in this country. While money is always available for new enterprises—often of a thoroughly unpractical nature—the creative work of older bodies is restricted and their usefulness impaired by a policy of cheese-paring economy, soulless in its outlook, but masquerading under the guise of rigid efficiency. Instead of supporting the Institute in every possible way, determined to bring success to its efforts because of the crying need of the Empire, our politicians and bureaucrats have taken away its house room and not only thrust the University of London, but now talk of putting the War Museum, into the building that was to be a beacon of light to the Empire. The neglect of the Imperial Institute is not the responsibility of this Government alone but of its predecessors also. And now the Economic Conference, the greatest, perhaps the last, opportunity of consolidating the Empire on a lasting foundation, will assemble under the shadow of a building that is a testimony against this generation for neglected opportunities. We are convinced that the essential preliminary to any scheme of Empire development is continuous examination of its resources and the co-ördination of the efforts of all bodies engaged in this field. There is now no proper central intelligence department, no coherent effort to bring into one focus all that is being done for the furtherance of Imperial trade and development. It is our intention to publish a series of articles in which the activities of the principal organisations will be impartially examined. The Imperial Institute will be the first.

The first and second of the series of articles referred to above appeared in the issues of *The Times Imperial and Foreign Trade and Engineering Supplement* for May 5 and 12, and are reprinted below :

Empire Trade and Development

An Inquiry into the Functions of Existing Organisations

1. The Imperial Institute

(*First Article*)

In its present form the Imperial Institute can hardly be regarded as anything more than a pale ghost of the great centre of Empire conceived by its originators. Planned on most ambitious lines in days when this country had not made up its mind whether Greater Britain was an asset or a liability, it possibly owed its failure to fill the *rôle* designed for it partly to being born ahead of its time—a fate which has befallen many of the world's greatest men and their ideas. There were other causes, prominent among them being the long, costly and unsuccessful efforts to make the Institute a social centre, in competition with an already established organisation. Into these it is useless to go to-day. The past cannot be undone and the only course of practical interest is to take things as they are, attempt to assess the value of the present activities of the Institute and indicate if possible the directions in which they might be usefully extended or curtailed. Some of the functions which were performed at one time by the Imperial Institute are now carried on by other bodies or by departments and representatives of various Empire Governments, and there is little prospect of any successful attempt being made to replace the present arrangements by a more centralised and comprehensive system. Such co-ordination as is desirable in these directions can be better effected in other ways.

Present Constitution

The present constitution of the Imperial Institute dates from April 1916, when an Act was passed transferring the property and management to the Secretary of State for the Colonies, with provision for an executive council of twenty-five members nominated by the Board of Trade, the Secretary of State for India (two each), the Ministry of Agriculture and Fisheries, the Government of India, the Governments of the Dominions (one each), and the Secretary of State for the Colonies (fourteen). The principal work of the Institute, which has been carried on since 1903 on these lines by its director, Dr. Wyndham R. Dunstan, F.R.S., is now concerned with the development

of the commercial and industrial use of the raw materials of the Empire. This task is divided into three departments—Investigation, Intelligence and Exhibition—which are provided with expert staffs with specialised scientific and technical qualifications. An important feature of the organisation is the system of advisory committees, of which there is one for India and each of the Dominions (in the case of the latter presided over by the respective High Commissioners), and five technical committees (Raw Materials, Mineral Resources, Ceylon Rubber Research, Silk and Timbers). There is also a Finance and General Purposes Committee. The Raw Materials Committee, of which Sir Algernon Firth is Chairman, includes representatives of the London, Liverpool, Manchester, Glasgow, Bristol, Norwich, Hull and Middlesbrough Chambers of Commerce, the Association of British Chambers of Commerce, and the Federation of British Industries.

In the case of minerals, a newer organisation known as the Imperial Mineral Resources Bureau was established in 1919 and there has since been some overlapping in this field between the Institute and the Bureau. This matter will be dealt with in a later article.

Investigation Department

In the remainder of the present article it is proposed to survey briefly the work already accomplished by the Investigation Department. The Intelligence and Exhibition Departments will be reviewed in a second article. A number of societies have their offices in the Institute building, and in some cases work in close co-operation with it. These are the International Association for Tropical Agriculture (British Section), the Empire Forestry Association (which works in conjunction with the Advisory Committee on Timbers), the Overseas Nursing Association, the African Society, and the Northbrook Society. The work of the two former will be discussed in a subsequent article. They occupy accommodation which could hardly be usefully employed by the Institute, consisting of a number of small rooms, and there is an obvious practical advantage in collecting as many as possible of such societies in one centre. Yet this statement must not be taken to imply that the Institute is over-burdened with space, and the official proposal to house the War Museum in the building should be strenuously resisted.

Inspection of the laboratories and testing-rooms of the Investigation Department must convince an open-minded inquirer that there is at least one side of the Institute's

work which is not only extremely valuable but might profitably be considerably expanded. The laboratories receive samples of new or little-known raw materials from the Governments of various parts of the Empire and from British representatives in foreign countries, and they also undertake special work for firms or private individuals in any part of the Empire on payment of the cost of the investigation. Mineral surveys have also been conducted in Ceylon, Nigeria and Nyasaland.

In the show-cases of the reference sample room are to be seen the results of many interesting and valuable investigations. Among these the writer was particularly impressed with the section relating to paper made from various materials not yet commercially used for this purpose. The bamboos which cover vast areas of British East Africa have been proved to be capable of being utilised for the manufacture of wood pulp for paper-making, and as there are local supplies—at Lake Magadi—of the soda required in the digesting process, there are good prospects of a pulp industry being established. Tenders for leases of bamboo lands are now being invited by the local Government. Papers of good quality have been made by manufacturers in this country from bamboo. Other African paper-making materials which have been shown to be quite satisfactory are tambookie grass and the spent wattle bark from which the tanning ingredient has been extracted. As the result of investigations by the Institute during the war, the extraction of wattle bark extract, formerly a German monopoly, is now being undertaken in South Africa, and the manufacture of paper and cardboard from the spent bark will follow. In view of the fact that before many years are past there is every probability of a severe famine in paper-making materials of the types now utilised, this work on possible substitutes will eventually prove to be of the greatest value.

Very useful work has also been done in connection with oil seeds, and as the result of the investigations conducted at the Institute Indian opium is now taking the place of the product of Persia and Turkey. During the four years 1916–19 nearly £400,000 worth of Indian opium was imported by this country for manufacturing purposes, whereas previously none was so employed. The utilisation of the Indian ajowan plant for the manufacture of thymol, formerly made almost exclusively in Germany, and the extraction of atropine from the wild Egyptian henbane, which has now become an article of export, are other interesting results achieved.

Improvement of the winding of Kashmir and Mysore silks leading to a great advance in the quality of fabric that can be made from them and the demonstration of the suitability of the extraordinary communal nests of the African anaphe moth as a source of raw silk are other achievements standing to the credit of the Investigation Department.

Some noteworthy accomplishments were the discovery of thorium-producing deposits in Ceylon, the location of the great Udi coal-field in Nigeria, which will eventually render our West African territories independent of imported coal, and the replacement, during the war, of Turkish boxwood by the boxwood of South Africa. On the initiative of the Timbers Committee tests were carried out, in conjunction with the Office of Works, which have led to the inclusion in the official timber specifications of that department of various British Columbian and Eastern Canadian timbers as alternatives to European woods. Much attention has also been devoted to cotton and jute.

These examples must suffice as an indication of what the laboratories of the Institute have already done. At present they are working on various problems connected with rubber in addition to pursuing the investigations of oil seeds and testing cement. So far the Institute has dealt with materials sent to it and has been able to cope with the volume of work without undue delay.

The Imperial Institute

(*Second Article*)

Investigation of raw materials with a view to their commercial exploitation naturally involves much more than laboratory work, which must be supplemented by the collection of a mass of economic information as to the extent of available supplies, cost of collection and transport, labour conditions, possibility of finding a profitable market, and so forth. The laboratory work of the Imperial Institute was briefly outlined in the preceding article, and it is now proposed to give a short sketch of the complementary activities of the Institute. Here it may be mentioned that a large and valuable body of information about the resources of the Empire has been accumulated and is available for the benefit of all who are interested in promoting development. The plan on which the Institute works is to conduct its investigations, not from the purely scientific point of view, but with a full

realisation of the commercial aspect. In brief, its object is to provide the technical basis for the fullest development of Imperial resources.

Information Bureau

The Technical Information Bureau is a branch of the Scientific and Technical Department. It collects, indexes, and arranges information which is likely to be of service, especially information of a technical and commercial nature in regard to the production, use of and trade in the chief raw materials of the Empire and of foreign countries. It also deals with inquiries received at the Institute from Governments, firms and individuals in this country and oversea. Requests for technical information in regard to industrial processes, methods of tropical agriculture, and prospects of agricultural and other industries in different parts of the Empire are also answered by this department. Space only permits of a single example of the class of inquiry dealt with being given, the work being so varied that it is quite impossible to give a comprehensive idea of its scope. The following instance is of special interest as showing the utility of the Institute as a medium for placing different parts of the Empire in touch with one another's products. At the request of the Director of the Commercial Intelligence Service, Ottawa, the chief Canadian Government Trade Commissioner in the United Kingdom consulted the Institute regarding the technical characters of the African timber known as Musharago, of which samples from Africa had been submitted to firms in Ottawa as a substitute for Circassian walnut. The wood in question is one of the most valuable of the hardwoods of Kenya, and probably also occurs in certain districts of South Africa. Samples were in the possession of the Institute, and a memorandum giving full information as to occurrence, character and uses of the timber, results of strength tests, and practical experience gained with the wood by the Uganda Railway was prepared and forwarded to the Canadian Trade Commissioner.

Technical Committees

Brief reference must be made to the work of the advisory technical committees, the constitution of which was mentioned in the preceding article. These committees, which meet as required, include representatives of the trades and industries concerned, who are in many cases nominated by bodies interested in the production or utilisation of raw materials. The committees advise as to the commercial development of materials which have

been examined at the Institute, and suggest subjects for investigation and inquiry. A senior member of the Institute staff acts as secretary to each committee, and other officers attend the meetings as required.

The Raw Materials Committee, which has as its principal object the discovery of commercial outlets for the raw materials examined at the Institute, took an active part in the discovery of a substitute for Sheffield lime for use as a polishing material in the Birmingham metal industry and in the production in this country of synthetic resins; numerous other useful lines of action have been initiated by this committee. The Silk Production Committee has taken an active interest in stimulating sericulture in the Empire with a view to reducing our dependence on foreign supplies, good work having been done in India and Cyprus. The Timbers Committee has done much to promote increased use of Empire woods, especially those of Canada and West Africa, in this country. The Mineral Resources Committee advises in regard to the preparation of the mineral publications of the Institute and considers questions concerned with development of mineral deposits. A number of monographs on minerals have been prepared chiefly by specialists selected by the committee and published by Mr. John Murray. The Rubber Research Committee, which works in conjunction with a similar body in Ceylon, now includes representatives of the Rubber Growers' Association and of the Research Association of British Rubber and Tyre Manufacturers. Many important questions relating to the quality of rubber have been investigated, and a new programme of research is now in hand.

Planting Industries Helped

Assistance in the establishment of planting and other industries overseas is an important feature of the Institute's work. The improvement of the Gold Coast cocoa industry and the establishment of tobacco-growing in Nyasaland may be mentioned as examples. In many cases the pioneer work has extended over a number of years and has involved examination and valuation of large numbers of samples of particular products grown on an experimental scale, supply of information and advice regarding methods of cultivation and preparation, remedying defects, requirements of users, and other questions relating to marketing.

A few figures showing the number of inquiries from various sources dealt with are of interest. Last year India was responsible for about 120, the Dominions about

260, Colonies and Protectorates about 475, firms and individuals in the United Kingdom more than 400, and other countries about 60, the total for the year being well over 1,300. India, which has, only temporarily it is hoped, suspended its grant to the Institute, was responsible for more inquiries than any one of the Dominions.

Exhibition Galleries

The exhibition galleries are now very well arranged on a definite plan, the object being to give a conspectus of the resources of the Empire by sections allotted to the different countries and also in certain instances to show samples of raw materials with the products manufactured from them. There are between thirty and forty separate collections of exhibits illustrative of the resources of the Empire oversea. Pictures, dioramas and transparencies add greatly to the educational value of the galleries, and for students of economics there are a number of graphs dealing with the production of the chief countries of the Empire. Last year over 150,000 people visited the galleries, this number including five thousand pupils from 180 different schools and institutions and their teachers. More than twice as many schools applied last year for conducted party facilities as could be dealt with by the present staff, and this year's experience is similar. There is no other exhibition in the Empire of a similar kind and there can be no doubt as to the educational value of these galleries, which only require efficient publicity to make them much more widely utilised. Only six members of the Institute's technical staff are directly engaged on work in connection with the galleries in addition to the lecturers for the conducted parties.

The exhibits in the galleries are often the starting point of inquiries and researches conducted by the Institute, and the collections are constantly utilised by its technical committees. From the educational point of view the value of the Institute's exhibition galleries would be much enhanced by the addition of a cinematograph hall, and it is to be hoped that it will be found possible to provide this desirable adjunct in the near future.

General Conclusions

The general impression made upon the writer by his recent visits to the Imperial Institute is undoubtedly that in its present form it is doing extremely valuable work, though much handicapped by an entirely inadequate income. At present its total receipts are about £30,000

per annum. The scientific and technical staff numbers just over forty. About twenty are engaged in laboratory investigations, about twelve on intelligence, and six are attached to the exhibition galleries. There is, however, no rigid segregation of the three departments. It will be generally agreed that this is a ridiculously inadequate staff to consider and investigate the resources of an Empire which includes one-fifth of the land surface of the globe. As a contrast, it may be mentioned that the Western Electric Company of America has over 1,500 technically trained men spending the whole of their time on research. It will probably be conceded by most people that the investigation of resources is a legitimate function of the State. Once an industry has been well established it should be left to it to conduct its own research work in connection with improvement of processes, possibly with some assistance from the State in regard to the more generalised scientific and technical problems that have to be solved. Admitting this much, we must, to be logical, also admit that the State should provide adequately for the investigation of Empire resources leading to establishment of new industries. This the Empire is certainly not doing at the present time.

It is true that the Dominions, India and a few of the colonies are now able to carry out some of the less complicated work of investigation of their own resources, but they still look to the United Kingdom for information and advice and to perform tasks which require elaborate laboratory research and practical tests in modern large-scale industrial plants. Thus in 1922 Australia and South Africa each initiated about ninety inquiries conducted by the Imperial Institute, while Canada and New Zealand originated about thirty-five each. The Institute works in close touch with oversea technical departments. The latter carry out the preliminary field work and select materials which appear to be worth detailed treatment, acting therefore as a sort of sieve for the Institute, and sorting out the promising subjects for investigation in London if their own research facilities are inadequate for the task.

Many of the Crown Colonies and Protectorates, however, do not possess the necessary trained *personnel* to undertake even the preliminary examination of their resources on a sufficiently comprehensive scale. This is a direction in which it is possible to see plainly the need for an expansion of the Institute's activities. If a small body of qualified experts was available for the purpose of forming flying survey parties, it would be possible to

despatch them to each of the Crown Colonies and Protectorates in turn. There they would make a thorough examination of the mineral and vegetable resources, selecting samples for investigation in London, and collecting such economic information as is needed to give a general idea as to the prospects of developing any industry suggested as a possibility by the existence of suitable raw materials. Naturally, if the Institute was in a position to undertake this task—it has, of course, in past years initiated several important investigations—its laboratory and intelligence departments would have to be greatly enlarged. Yet when we compare the scientific staff of forty employed by the Institute to investigate the raw material resources of the Empire with the 1,500 research workers of a single industrial organisation in the United States it is difficult to resist the conclusion that as a people we are still less than half awake to the importance of devoting a sufficient portion of our national income to that properly-balanced investigation of our untapped wealth that represents the foundation upon which our future prosperity must depend. The contribution of the British Government is £10,000 a year, conditional upon three times as much being provided by other parts of the Empire. The fact that the Association of British Chambers of Commerce has represented to the Government the need for more generous treatment of the Imperial Institute shows that at least one business organisation is alive to the value of the work it is doing.

The Imperial Institute and India.—The following article appears in *Indian Engineering* for May 5, 1923.

THE IMPERIAL INSTITUTE

The question of the severance of India's connection with the Imperial Institute has recently attracted some attention, and it may on that account be interesting to give some information regarding the constitution and objects of an Institute which was founded with considerable enthusiasm, but which in the opinion of the Government of India now serves no useful purpose. The Imperial Institute was founded by the united effort of the people of Great Britain and the British Commonwealth and Colonies overseas on the initiative of King Edward VII as the Empire Memorial of the Jubilee of Queen Victoria, and from the contributions received from all parts of the Empire the building in London was constructed and a capital sum invested as an endowment fund. It was intended that the Institute should be a

centre house for information and investigation for the commercial development of the natural resources of the Empire and the promotion of inter-Imperial commerce and industry.

The first Corporation of the Institute appears to have devoted much energy to making it a place of popular resort, but the income proved to be insufficient for maintaining facilities of that kind in addition to the principal purpose for which the Institute was founded, and in 1900 the building and funds were transferred to H.M. Government with the main object of promoting the utilisation of the resources of the Empire. In 1902 an Act of Parliament placed the management in the Board of Trade with an Advisory Committee of representatives of the Dominions, Colonies and India, as well as of the Colonial and India Offices, and the Boards of Trade and of Agriculture. In 1916 another Act transferred the property and management to the Secretary of State for the Colonies, and it provided for an Executive Council consisting of twenty-five members, nominated by the Board of Trade, the Secretary of State for India, the Ministry of Agriculture and Fisheries, the Government of India, the Government of the several Dominions and the Secretary of State for the Colonies. These changes are mentioned, but the main point is that since the beginning of the century the available funds have been devoted to the development of the commercial and industrial use of the raw materials of the Empire.

The work is carried on in the three principal departments of Investigation, Intelligence and Exhibition, the staff of which includes officers with special qualifications in chemistry, botany, geology, mineralogy, and in certain branches of technology, in their relation to the utilisation of raw materials. Associated with this work are a number of Advisory Committees, and each of the Dominions and India has a Special Committee of members with knowledge of the trade and industries of these countries. In addition there is a Raw Materials Committee, appointed by the British Chambers of Commerce, concerned in making known to the commercial community results of investigations which are of importance to trade and commerce. The laboratory work of the Institute is principally concerned with discovering the appropriate use for any particular materials, and this department issues each year hundreds of reports on thevalue and the use of mineral and vegetable raw materials. The Intelligence branch has for its business the collection and reviewing of all published information respecting the origin and uses of raw materials,

and in answering the numerous enquiries made to the Institute from all parts of the world. The Exhibition galleries display collections of importance in connection with the work of investigation and intelligence, and for commercial purposes.

It will be gathered from the above that the operations of the Imperial Institute not only help to develop the resources of overseas countries but to promote inter-Imperial trade between the constituent parts of the Empire, and it is because the Institute is in close touch with producers and the conditions of production that it is in a unique position to promote this co-operation for the mutual benefit of all the countries concerned. In the matter of drugs, for instance, the Institute has demonstrated the value of Indian opium for medicinal purposes and for the manufacture of morphia and other alkaloids. It has also led to the seed of the Indian ajowan plant being utilised for the manufacture of thymol, which was formerly manufactured in Germany. Much work has been done in connection with the numerous kinds of beans grown commercially in Burma, and in the essential oils produced in the United Provinces. In oil seeds, safflower, linseed, perilla, kapok, toria and others, there has been much scientific investigation. In fibres, jute, sunn hemp, kapok, cotton, talipot palm, bamboo and cotton stalks for paper making; in drugs, belladonna, datura, *Strychnos nux-blanda* seeds, senna, derris root and camphor; in tobacco; in timbers for match-making; in tanning materials; in minerals, corundum, bauxite, micanite, and lignite; in miscellaneous materials, casein, beeswax, resin, rubber, and many others, the Institute has rendered the most valuable services by scientific examination and advice. In fact, it is impossible in a short space to give an adequate idea of the wide scope of the Institute's technical work of great importance and possibilities in the interests of all the outlying parts of the Empire including India. The history of industry and commerce, as Dr. Gibbons said in his work on the subject, is the history of civilisation, and no country in the severe competition of the day can afford to neglect potentialities of wealth. Yet the Government of India have thought fit to decide that the operations of the Imperial Institute were of such little use to India that there was no reason for continuing the very small annual contribution towards its upkeep.

But that opinion, as we mentioned in our article of November last, was not shared by the Association of British Chambers of Commerce, and since then the Association of Chambers of Commerce of India and Ceylon have,

we understand, almost unanimously taken the same view. It is impossible for us to believe, as the Government of India appear to think, that the interests of India are safe in the hands of the Indian Trade Commissioner with his restricted office and no opportunities for scientific research. The issues at stake are far beyond his range of influence, and it is for the business men of the country to consider whether the retrenchment of a petty grant is, or is not, penny-wise and pound-foolish.

Empire Forestry Association: Presidential Address by H.R.H. the Prince of Wales.—At the First Annual Meeting of the Empire Forestry Association, held at the Guildhall, London, on March 2, 1923, His Royal Highness delivered the following address:

"My Lord Mayor, Ladies and Gentlemen,—In moving the adoption of the accounts and report, I would like to say how very pleased I am, as President of the Empire Forestry Association, to be present here this afternoon, and how grateful we all are to the Lord Mayor for having so kindly placed the Guildhall at our disposal on this occasion.

"Though I cannot in any way claim sufficient technical knowledge of forestry to justify my being in the Chair this afternoon, it is a subject which has always aroused my keenest interest, and I have had in the last three years unrivalled opportunities of realising the vast timber resources of our Empire, and I have actually had the good fortune to visit lumber mills in Canada and Australia.

"Now the Empire Forestry Association deserves, and I trust that it will receive, support from all those throughout the Empire who recognise the vital importance of forestry to the life of a nation, and the need for looking ahead and promoting systematic planting and conservation of existing forests, if we are not to lose one of the most important resources of civilisation. Without a cheap supply of timber any progressive community must face disaster, having regard to the many needs we have for timber in everyday life, for which a regular and cheap supply is essential. This, however, can only be secured by close attention to forestry in all its aspects. If we are to accept the evidence of those who have made a study of the rate of consumption of timber, the world, within the next twenty years, will be faced with a timber shortage, if not an actual famine. No time must be lost in making provision for future supplies. Steps must be taken to replant the vast forest areas devastated during the Great

War. These are estimated in Great Britain alone at one million acres, of which probably not 5 per cent. have been replanted up to the present time.

" In addition to the one million acres cleared during the war, it is estimated that in Great Britain there are three million acres suitable for afforestation and for no other purpose, and the time is opportune, particularly in view of the urgency of finding solutions for the problem of unemployment. The Empire Forestry Association, as a great voluntary organisation, can do effective work by bringing home—not only to the people of this country, but to other countries of the Empire—the need for action by the State, and also by private enterprise, which, if judiciously encouraged, can do so much in this matter. This is one of the several directions in which, by propaganda, the Empire Forestry Association should be able to render a most important Imperial service, and I trust that the doctrine will be preached not merely in London, but by speakers throughout the Provinces, and especially in those country districts in which the need for action is apparent.

" This country, however, can never expect to be able to grow all the timber it consumes, and certain woods must be got from warmer countries. Considering how almost every kind of climate can be found within our Empire, it is unsatisfactory to learn that by far the greater part of the timber used by us is brought from abroad. This state of affairs suggests an alluring programme of operations for the Empire Forestry Association to carry out with the hope of remedying, even to a small extent, this deficiency in the forest production and economy of the Empire. The need for systematic forestry must be more fully realised, and the doctrine of self-regeneration of forests no longer relied on as the sole means of propagation.

" Another aspect of the many-sided work of the Association is to promote the use of the lesser-known timbers of the Empire, including those of tropical countries, many of which are scarcely known in commerce. In this connection the Association should find it an advantage to have made its headquarters at the Imperial Institute, with access to the varied collections of tropical timbers which are shown there, and to have established co-operation with the Timbers Committee of that Institute in bringing about a better knowledge of the timbers of our Overseas countries and their commercial usage.

" The interests, too, of timber growers in Great Britain must not be overlooked, and every effort must be made to popularise the use of home-grown timbers, whose

valuable properties have only to be known to be better appreciated, provided they were placed on the market in the same form and condition as the foreign article.

"From the Empire point of view it is hoped that the Association will play an important part in organising the Forestry section at the British Empire Exhibition of 1924 by establishing an Imperial Forestry Enquiry Bureau which will act as a clearing house for information and be a key to every exhibit incidental to forestry at Wembley.

"Gentlemen, I am not here to enlarge on the aims and objects of the Association, for these were fully dealt with by more competent speakers than myself at the Inaugural Meeting just over a year ago, but in moving this Report I sincerely trust that this Association will gain the support throughout the Empire that it deserves, and that to become a member and supporter of the Empire Forestry Association and its sister Associations in the Dominions will be recognised as the duty of all those who realise the high importance of the varied work which the Association desires to carry out."

Copper Ores and Mercury Ores: Imperial Institute Monographs.—Two further volumes in the series of monographs on mineral resources issued under the direction of the Mineral Resources Committee of the Imperial Institute have been published recently by Mr. John Murray. They deal respectively with Copper Ores and Mercury Ores.

Copper Ores.—This volume has been prepared by Robert Allen, M.A. (Cantab.), B.Sc. (Lond.), M.Inst.M.M., Scientific and Technical Department, Imperial Institute. It consists of 221 pages, and is divided into three chapters, the first of which briefly deals with the ores and mineral associations of copper; enrichment of the ores; classification of the deposits; mining and metallurgy, the latter being illustrated with a chart; the world's chief copper refineries; the cost of producing the metal; grades and prices; association of buyers and sellers; the uses of copper; descriptions of its more important binary and ternary alloys; substitutes; consumption; control of the world's copper resources; and the world's production.

The second chapter gives an account of the sources of supply of copper ores in the British Empire, and includes descriptions of the more important deposits of Canada, viz. those in British Columbia, Manitoba, North-West Territories, and Ontario, and also of those of Queensland, South Australia and Tasmania. There are also references to minor occurrences of copper in Great Britain,

British Borneo, Cyprus, India, British Africa, Newfoundland, Papua and New Zealand.

The third chapter treats of foreign sources of supply, and describes the principal copper deposits of Germany, Norway, Russia (in Europe and Asia), Spain, Japan and Formosa, Korea (Chosen), Belgian Congo, Cuba, Mexico, United States, Chile and Peru, with references to the less important occurrences in Austria, Bulgaria, Finland, Greece, Hungary, Italy, Portugal, Rumania, Sweden, Yugo-Slavia, China, Dutch East Indies, Persia, Angola, Portuguese East Africa, Argentina, Bolivia, Brazil, Colombia, etc. The monograph contains six diagrams, a map of the world showing the copper occurrences referred to in the text, and a bibliography with some 300 references.

Mercury Ores.—This work has been prepared by Edward Halse, A.R.S.M., M.Inst.M.M., Scientific and Technical Department, Imperial Institute, and consists of 101 pages. The first of the three chapters into which the book is divided deals with the mercury minerals, and the methods of mining, concentration and reduction; and also with the properties, uses, value, and world's production of the metal.

The second chapter describes the known deposits of the British Empire, *e.g.* British Borneo, Transvaal, Canada (Kamloops Lake and Vancouver Island, British Columbia), Australia (Yulgilbar and Pulganbar, New South Wales; Kilkivan and Cooktown, Queensland; and Myponga, South Australia), and New Zealand (Puhipuhi, Kanaeranga Valley, Mackaytown and Ohaeawai—all in the North Island).

The third chapter gives an account of the foreign sources of supply, and describes the principal mercury deposits of Germany, Italy, Russia, Spain, Yugo-Slavia, Asia Minor, China, Algeria, Mexico, the United States and South America. In the case of the last-mentioned country a description is given of the famous Santa Barbara mine in Huancavelica, Peru, and references are made to deposits in Brazil, Chile, Colombia, Dutch Guiana, Ecuador and Venezuela.

A map shows the principal mercury occurrences in the world, and the monograph concludes with a list of references to the literature of the subject.

The Estimation of Fat in Casein.—The presence of a high percentage of fat in commercial casein is undesirable and contracts usually specify that the amount present shall not exceed a certain limit. Its exact estimation is

therefore of considerable importance. The intimate manner in which the fat is associated with the nitrogenous constituents of the casein render its extraction by means of ordinary solvents extremely difficult, and owing to this circumstance estimations made by different observers of one and the same sample may give discordant results. Indian casein, for example, examined at the Imperial Institute gave consistently low results for the percentage of fat when extracted with ether in a Soxhlet extractor, but much higher results were obtained by the Werner-Schmidt method, in which the casein is heated with hydrochloric acid before the fat is extracted. A sample of Indian casein examined by this method was found to contain 7·4 per cent. of fat, but Gangolli and Meldrum in India, using the Soxhlet ether extraction method, found only 0·24 per cent. in another specimen of the same casein, and they state that their figure was confirmed by the use of a new " absolute method " which they had devised (*Bulletin*, No. 4, 1921, *Department of Industries, Bombay*).

The difference being of such a fundamental nature, the published methods for the estimation of fat in casein were subjected to a comprehensive study at the Imperial Institute, and the results have been given in a paper on " The Estimation of Fat in Casein," by G. T. Bray, A.I.C., and F. Major, B.Sc., A.I.C., read at a meeting of the London Section of the Society of Chemical Industry on February 5, 1923 (*Journ. Soc. Chem. Ind.*, 1923, 42, 106T).

Experiments showed that the fat is not completely removed from dry casein by extraction with ether in a Soxhlet extraction apparatus even after the process has been continued for 31 hours.

Results obtained by the Röse-Gottlieb method, in which the casein is dissolved in dilute ammonia, were not concordant and were lower than those found by the Werner-Schmidt method. Moreover, in the former method it was often difficult to get the casein to dissolve satisfactorily in the dilute ammonia, even on warming.

The Werner-Schmidt method was found to give the most concordant and trustworthy results. According to the details recommended by the authors, the casein is dissolved by warming it with 4 parts of hydrochloric acid (sp. gr. 1·16) and 2 parts of water for 40 minutes. The solution is then shaken with ether, and the residue left after removing the ether from the ethereal extract is finally extracted with light petroleum to isolate the fat.

Gangolli and Meldrum suggested that the fat obtained by this method contains products of the hydrolysis of the

casein and that the method therefore gives results that are too high; but this contention was shown to be untenable. From experiments carried out at the Imperial Institute it was evident that conditions even more favourable for the hydrolysis of the casein do not influence the percentage of fat obtained and also that the petroleum-soluble matter (fat) obtained does not contain sufficient nitrogenous hydrolytic products to vitiate the accuracy of the estimation.

The new "absolute method" recommended by Gangolli and Meldrum was shown to be entirely unreliable and to give low and inaccurate results, as by this method the fat is not completely extracted. The casein does not dissolve satisfactorily in the caustic soda solution used, and it was found that the whole of the fat is not removed completely by the one extraction with ether, which, according to the published account of the method, is stated to be sufficient.

As a result of the experiments carried out it was concluded that the Werner-Schmidt method was the best and most reliable method for the estimation of fat in casein, and that the percentage of fat (7·4), found by the Institute in a sample of Indian casein and considered by Gangolli and Meldrum to be inaccurate, is correct.

In the course of the discussion which followed the reading of the paper, Mr. M. S. Salamon supported the statement that the Werner-Schmidt method was the only one which gave consistent results, and that all the other methods gave low results.

The African Oil Palm in Angola.—In the article on this subject (this Bulletin, 1922, **20**, 152) it should have been stated that Mr. Dawe was sent to Angola, on the nomination of the Imperial Institute, not by the Portuguese Government but by the Fomento Geral de Angola, a Portuguese company operating in Angola with headquarters at Lisbon.

Sillimanite: a High-grade Refractory Material.—Crystalline anhydrous aluminium silicate occurs in rocks in three forms, as sillimanite or fibrolite, as andalusite, and as cyanite. These three minerals, although identical chemically, have quite distinct physical properties. Sillimanite is much the most stable of the three, and the others may be converted into this form by heating to above 1,320° C.; it may be produced artificially by fusing together silica and alumina in the correct proportions or by other methods.

Sillimanite is found widely distributed in gneisses and

crystalline schists and in the detrital rocks derived from these; less often it occurs in zones of contact metamorphism, and still more rarely in granites. It is especially characteristic of the khondalite gneiss of India. In most cases the mineral is disseminated in grains or aggregates of fibres throughout the rock, the massive variety being extremely scarce. Recently, however, the occurrence in India of massive sillimanite has been brought to the notice of the Imperial Institute. The mineral is stated to occur near Nongmaweit in the Khasia Hills of Assam, in the form of boulders. Details are at present lacking, but if the experimental work now being carried out proves successful and the difficulties of transport (which are very great in this mountainous tract) can be overcome, an attempt will be made to develop the deposit and place the sillimanite on the market as a high-grade refractory material.

Sillimanite has many valuable properties which render it suitable for use as a refractory material, amongst which are strength and toughness, high melting point (about 1,810° C.) and stability up to that temperature, low co-efficient of expansion, low electrical conductivity, freedom from volume changes, neutral reaction, and resistivity to corrosive slags and to oxidising and reducing conditions.

This suggested use of sillimanite seems to arise naturally out of its synthetic development in furnace linings and pots used in glass-making, where it is formed by the action of fluxes, derived from the glass or present in the hot gases, on the aluminous materials of which these linings, etc., are made. Under these conditions a layer of sillimanite is produced, which acts as a protective coating and prevents the molten glass from coming into direct contact with the clay body of the tank or pot. It is obvious, therefore, that from a theoretical point of view a refractory material composed wholly or mainly of sillimanite would be ideal for use in glass manufacture.

In practice, however, the use of sillimanite as a refractory material is still in the experimental stage; and in spite of the desirable qualities mentioned above, it is not yet commercially available owing to the scarcity of the natural mineral and the expense involved in producing it artificially.

Fused artificial sillimanite has been produced by the Malinite process of smelting aluminous rocks or minerals with a reducing agent.

Experiments have also been carried out with mixtures resembling sillimanite in composition by the American

Refractories Company in conjunction with the Mellon Institute, and it is said that the production of such refractory materials in quantity has already commenced. Published results, however, refer to tests performed on bricks containing a much higher percentage of alumina than does sillimanite, but it is stated that the composition of the material used will eventually approximate as closely to that of sillimanite as possible.

A process has been patented in America for the manufacture of refractory bricks from a mixture of artificial sillimanite and of finely ground natural zirconia, the amount of the latter varying from 5 to 75 per cent.

Though the first cost of sillimanite refractories may be higher than that of less refractory materials, it is probable that eventually it will be found that their greater durability will more than compensate for the difference.

RECENT PROGRESS IN AGRICULTURE AND THE DEVELOPMENT OF NATURAL RESOURCES

In this section of the BULLETIN *a summary is given of the contents of the more important papers and reports received during the preceding quarter, in so far as these relate to tropical agriculture and the utilisation of the natural resources of the Colonies, India and the Tropics generally. It must be understood that the Imperial Institute accepts no responsibility for the opinions expressed in the papers and reports summarised.*

AGRICULTURE

FOODSTUFFS AND FODDERS

Tea.—The factors affecting the quality of tea form the subject of an interesting communication to the *Quarterly Journ., Scientific Dept., Indian Tea Assoc.* (1922, Part II, p. 44). An account is given of extensive research work carried out on different grades, with a view to determining the relations between the composition of the tea and the market price. Particular attention was devoted to the tannin, since the astringency of that substance influences the taste of the liquor, and is responsible for "briskness" and "pungency." The tasters' reports, in conjunction with the analyses, showed that there is only a very rough correspondence between the quantity of tannin present in manufactured leaf and the price. The ordinary method of estimating "total tannin" records only unfermented tannin and not the substances produced from it during manufacture and which have an influence on the properties. The tannin content of fresh leaf under varying conditions of pruning, plucking, shading and manuring

was determined, and also its variation with the season of picking. The results have led to the provisional assumption that the quantity of tannin present in the fresh leaf, which is a measure of the unfermented tannin and tannin products in the manufactured tea, does directly influence quality, although it is not the only factor and its influence can be masked by differences in manufacture. From the graphs which are given, showing the variation in tannin content with season, it is seen that at the beginning of the season the tannin is low, particularly in the earliest pluckings. This agrees with the well-known fact that the first flush does not make teas up to the average quality of the season. The graphs further indicate that the tannin content is at about its maximum during August and September and tends to fall off in October. The quality, on the contrary, improves after the end of September, and the authors suggest that other factors at this time are so active as to outweigh the influence of the tannin. Such factors are likely to be an increase in flavour due to the increased formation of aromatic substances, and an improvement in quality due to the fact that the better atmospheric conditions at this season for withering and fermenting exert an influence on both tannin and aroma.

The latter part of the paper deals with the control of the successive stages of manufacture based on present knowledge of the chemical nature of the changes which occur in withering, rolling, fermentation and firing.

A report on the production of tea in India in the year 1921 appears as a supplement to *Ind. Trade Journ.*, January 11, 1923. It comprises 26 pages, consisting chiefly of statistics; the total area under tea in India in 1921 was 709,100 acres, which is nearly 1 per cent. larger than that of the preceding year.

Sweet Potatoes.—*Bull.* 1063, 1922, *U.S. Dept. Agric.*, deals with the storage of this crop, to which over a million acres are annually devoted in the United States, where, among the vegetable crops, it is second in importance only to the Irish potato. Experiments showed that commercial handling may result in losses on storing as high as 20–40 per cent., with an average of 10 per cent. due to shrinkage and decay, but with care it is possible to store the tubers for four months with losses as low as 7·52 per cent. Sorting at intervals during the storage period resulted in greater losses due to decay than when sorting was omitted. In these experiments the varieties Nancy Hall, Southern Queen and Big Stem Jersey showed greater shrinkage

when stored in crates than when stored in bins. The Southern Queen showed least decay and Nancy Hall the least shrinkage in bins, while Big Stem Jersey was the worst in both these respects.

The storing and bedding of selected seed stock of sweet potatoes is the subject of *Bulletins* 39 and 40, 1922, *Virginia Truck Exper. Station.* The selection of the best tubers and the curing and storage in barrels are described, together with methods of preparing sprouted tubers in hot-beds.

Wild Rice.—In *Circular* 229, 1922, *U.S. Dept. Agric.*, attention is drawn to the nutritious and palatable properties of the grain of American wild rice (*Zizania aquatica*, Linn. = *Z. palustris*, Linn.), the value of which as a food is not generally known. The Indians of the upper Mississippi Valley gather it and sell what they do not require for their own use. It may be boiled and served as a vegetable with meat, and could readily take the place of potatoes and cultivated rice in an ordinary diet. Wild rice is a fresh-water plant, and grows best in shallow lakes and on mud flats and low marshland bordering tidal rivers above the limit of brackish water. The change of water level does not injuriously affect its growth, and the plant does well wherever it can establish itself in a thick layer of mud irrespective of the nature of the soil. The rice is a tall annual grass ranging from 7 to 11 feet in height. The seed is long and slender and almost cylindrical, with a thin brown, tightly adhering husk and bearing a long, stiff, twisted awn. The kernel is from ½ to ¾ in. in length, and when fully mature is purplish black. When kept in dry storage, the seed loses its vitality, and only seed of guaranteed germinative power should be employed for sowing, which should take place in the spring. The seed should be broadcasted from a boat on a rising tide when the water is about a foot deep. The seed will sink at once by its own weight, and the plants may be removed for transplanting when they are from 12 to 15 in. high. The Indians harvest the crop in a very primitive way by bending the stalks over a boat and lightly knocking the grain into the boat. On account of the lack of uniformity in ripening the harvest period may extend over several weeks. The seed is dried by exposure to air but not sun, and in ordinary circumstances may be sufficiently dried by turning it several times during the first day after harvest.

An account of the cultivation of the wild rice of Asia (*Z. latifolia*) is given in *Rev. Bot. appliquée* (1922, **2**, 465).

Efwatakala Grass.—In an article dealing mainly with the feeding value of this grass, published in this BULLETIN (1922, **20**, 300), it was pointed out that it would be worth while to experiment with it in certain African colonies. In this connection attention may be drawn to a letter printed in the *Farmers' Journ.*, December 7, 1922, from the Chief Agriculturist and Botanist, Rhodesia, which records his experience with the grass in that country. The form introduced there is *Melinis minutiflora* var. *pilosa*, Stapf. The letter states that the grass is difficult to establish from seed over large areas, and that it matures its seed late with the result that the latter is often damaged by frost. Owing to its late flowering the grass can often be cut for hay after the rains have finished. It is also a valuable autumn grazing grass, but is sensitive to cold. It was found that stock will not at first graze it readily unless paddocked on it; the hay, which is coarse, is eaten freely when stock have once become used to it. The yield of hay from an established field is considerable and from one cutting (all that is usually obtained) three to five tons per acre may be secured. The writer states that he has had no experience of the insect-repelling properties which have been attributed to the grass.

J. B. Rorer, formerly mycologist to the Board of Agriculture, Trinidad, writing from Ecuador, states in *Journ. Jamaica Agric. Soc.* (1922, **26**, 597) that efwatakala grass has the reputation in that country of being a tick and mosquito worm repellent, that it is easily propagated from seeds and runners, grows rapidly and is liked by stock. He adds that the characteristic odour is very agreeable to most persons.

Oils and Oil Seeds

Coconuts.—The main cause of bad colour and acidity in copra is ascribed to the action of moulds, and it is therefore essential that copra should be well dried. In the case of large plantations the most economical method of drying is by means of steam, using modern machinery, but on small plantations this method is not profitable owing to the comparatively high initial cost and overhead expenses of steam-driers. The problem of copra drying on small plantations has engaged the attention of the Bureau of Science of the Philippine Islands, who have found that sun-drying after exposure to the fumes of burning sulphur gives satisfactory results (see this BULLETIN, 1918, **16**, 251). This process has been in operation for several years, and an article in a recent

number of the *Philippine Journal of Science* (1922, **21**, 49) records certain modifications that have been found advisable. Details are given of the construction of the chamber in which the copra is treated with the fumes of burning sulphur. This chamber is built to hold 3,000 nuts at one charge, and for this quantity one kilogram of sulphur is required and the process lasts about four hours. Although the nuts may be sulphured before the removal of the shells, it is recommended that they should be submitted to a preliminary drying in the sun whereby the kernels are loosened from the shells. The kernels are then separated from the shells by a knife and transferred to the sulphur chamber. After this treatment the product may be dried in a shed, should the weather be unfavourable for its being spread out in the sun. The final copra is generally lighter in colour than the whitest ordinary sun-dried product, and contains about 5 per cent. of moisture and 1 per cent. of free fatty acids.

According to the *Report of the Director of Agriculture, Federated Malay States*, for 1921, coconut cultivation still continues to be a steady and sound agricultural industry in that country, and the price of copra, although considerably lower in 1921 than in the previous year, maintained a fairly satisfactory level. There has, however, been no increase in the local manufacture of coconut oil and no additional mills have been erected. The quantity of copra exported increased from 500,000 cwts. in 1920, valued at £1,075,268, to 724,000 cwts. in 1921, valued at £878,132. The greater part of the copra exported comes from Perak, Selangor being next in importance.

Investigations have recently been commenced on the "lesser" coconut spike moth in the Federated Malay States and the results are published in the *Malayan Agricultural Journal* (1922, **10**, 136). Caterpillars of this moth cause injury to the flowers while still enclosed in the spathe and the yield of nuts is thereby decreased. From field observations and examination of the spikes, this insect would appear to be the principal pest of coconut spikes, a large number of female flowers being found to be injured before the spikes have opened. Experiments are being carried out in order to ascertain whether injured female flowers can produce nuts, whether uninjured flowers on a damaged spike reach maturity and whether all the female flowers on an undamaged spike reach maturity. From a study of the life-cycle and from observations in the field, it would appear that the eggs are laid about fifteen days before the bursting of the spike. Any treatment to

prevent either the eggs from being laid or the caterpillars from entering the spike should therefore be carried out before the spike is more than half grown. Control experiments are being conducted in which (1) substances are injected into the spike, (2) the spikes are sprayed with poisonous substances and (3) the spathe is painted with probable deterrents to the moths and with substances affecting the eggs. No recommendations can yet be given for the control of this insect.

The same *Journal* (p. 122) describes the work on the selection of coconuts for seed purposes carried out by the Botanical Division of the Department of Agriculture, Federated Malay States. The seed-nuts for all the spacing, cover-crop and manurial tests hitherto carried out by the Department on the Sapintas Estate were obtained from one of the oldest and most uniform estates in the country. The collection of seed-nuts from such a reliable source constitutes the simplest form of selection, but it has the disadvantage that as the nuts are generally collected from piles accumulated at the store the resulting trees are of only average quality. A much more uniform plantation is obtained by marking as parents individual trees which show desirable characters or which closely approximate to an approved type. The number of nuts which a tree can produce is not a reliable index of the ability to produce a high yield of copra, but account must also be taken of the size of the nuts, their shape, thickness of kernel, etc., characters that vary greatly in different trees. The only certain method of producing uniform and high-yielding estates is the production of pure strains of coconuts, but this method lies rather beyond the power of the planter because it necessitates initial work on at least three generations of trees. This work has, however, recently been inaugurated by the Department of Agriculture. Experience has shown that the type of coconut to select for future plantations is a medium-sized rounded nut. It has not been found possible to select nuts by the quality of the oil that they contain, and experiments conducted by the Chemical Division appear to indicate that the quality of the oils contained in different types and varieties of nuts does not vary to any appreciable degree. Comparative yield trials as a basis for seed selection are being conducted by the Botanical Division, the seed-nuts used having been obtained from seventy trees which field examination had shown to be heavy producers. A comparative study is also being made of the different types of coconuts grown in Malaya and other countries, with a view to obtaining clues to correlation

and variation factors and to ascertaining the capabilities of the different varieties.

Ground Nuts.—Nearly 59,000 gallons of ground nut oil and over 150,000 bushels of ground nuts were imported into Australia in 1921. It is felt that in a country like Australia, which is so well adapted for the cultivation of this oil seed, sufficient quantities should be produced locally to meet the requirements of the home market and to permit of some being exported. The product is chiefly employed in the Commonwealth for dessert purposes and for use in the confectionery and oil trades. There are large areas of land suitable for the crop, particularly in Queensland and New South Wales (*Agric. Gaz., N.S.W.*, 1922, **33**, 855). Experiments conducted by the Department of Agriculture in the latter State have already demonstrated the possibility of obtaining high yields. More recently a trial has been carried out to ascertain the effect of manuring White Spanish ground nut plants with artificial phosphatic fertilisers. The sowing was made on a light grey sandy soil that had been cleared just previously. By the use of 3 cwts. of a fertiliser consisting of equal parts of superphosphate and bonedust, the yield of nuts per acre was increased by about 10 per cent. The marketing of ground nuts has always been a serious problem in Australia, as the imported article arrives graded, clean and bright, and local growers must therefore be prepared to supply a product of the same standard. An oil mill capable of handling 2,000 tons of nuts is being erected in Sydney, where the nuts will be separated into three grades, viz. (1) for confectionery purposes, (2) for the roasting trade and (3) for oil expression. The first two grades will compete with the oriental product, but will have the advantage of the protective tariff. Undersized, broken and stained nuts which are unsuitable for either of the other purposes will be utilised for oil production. The three varieties grown in Australia are Valencia, much favoured by the confectionery trade, Chinese suitable for roasting and White Spanish for use in the oil mills. Samples of the Valencia variety grown at the Grafton Experiment Farm have been pronounced by a Sydney firm as equal in flavour to the best imported nuts for roasting. With the exception of a leaf-spot fungus (probably *Cercospora personata*) no pests or diseases have been recorded in Queensland.

Miscellaneous.—*Centrosema Plumieri* is being extensively planted on many estates in Malaya as a cover-crop, and as there is a likelihood of there being considerable quantities

of seed available, the latter has been examined by the local Department of Agriculture with a view to ascertaining whether it contains sufficient oil to warrant its use as an oil seed. The results of the work which are published in the *Malayan Agricultural Journal* (1922, 10, 30) show, however, that it contains only 1·25 per cent. of oil and is therefore of no value as an oil seed.

Rubber

Hevea brasiliensis

Native Rubber Cultivation in Sumatra.—According to the *Netherland Indies Review*, December 1922, p. 299, rubber is cultivated at Bila, on the East Coast of Sumatra, by the natives on a fairly large scale. The native-owned plantations differ from those under European control in several important respects. The trees are planted very closely so as to obviate trouble with weeds, whilst the juice of the so-called *assem gloegoer* is used to coagulate the latex, and the sheets are rolled by means of an ordinary hand roller or even a bottle. Chinese dealers buy the product, which is worked up in European factories in Singapore in such a way as to fetch a price equivalent to that of second-grade rubber from European estates.

Tapping.—The *Bulletin of the Rubber Growers' Association*, October 1922, p. 510, contains an article by Sidney Morgan on the systems of alternate periodic daily tapping and resting. These systems of tapping are specially important since they enable estates (1) to arrange a beneficial scheme for a restricted output, and (2) to reduce the cost of tapping per lb.

From a study of the results obtained on estates where the new systems have been longest in practice, the writer has arrived at the following conclusions:

(1) On the whole it is found that the output of the second month is the best.

(2) From an analysis of weekly output it is not possible from the data available to state which week of the second month gives the maximum output owing to varying weather conditions. The evidence available indicates that the last week of that month is as good as any other.

(3) In some cases the third month gives the best result on equal periods of tapping and resting; or a result approximating to that of the second month. However, it is generally found that the output of the latter portion of the third month falls below that of the opening days.

(4) In periods of half tree tapping extending over

four months there is generally a decided decrease in the gross output of the fourth month.

(5) More complete records of experiments carried out on a large scale are necessary to determine definitely the optimum period of tapping and resting, but the writer is of the opinion that two months is the optimum period.

Latex Preservation.—The *Malayan Agricultural Journal* (1922, **10**, 151) contains an article by B. J. Eaton on the preservation and packing of latex for shipment. Of the various preservatives for latex a number are known which in some respects are more satisfactory and economical than ammonia; but in the absence of information as to the purposes for which the preserved latex is to be employed, ammonia is the only preservative which should be used except in the case of a small experimental shipment. The solution of ammonia (sp. gr. 0·880) should be added to the extent of 2 per cent. of the volume of the latex.

In order to save freight the latex should be collected "dry" and should contain about 3 lb. of rubber per gallon. It should be strained carefully and the ammonia added as soon as possible after the latex reaches the factory.

Preserved latex can be shipped either in kerosene tins sealed by soldering and packed two per case so that they fit tightly; in steel drums; or in tanks or tank steamers.

Rubber Preparation.—The Rubber Growers' Association and their chemist in the Federated Malay States have patented the use of hydrofluosilicic acid and its salts, particularly the sodium salt, as a coagulant of latex. It is claimed that these compounds possess an advantage over acetic acid in that they restrain "oxidation" of the latex and diminish the tendency of rubber prepared in sheet form to become mouldy. Moreover, the sodium salt is easier to handle, cheaper to use and more easily shipped than acetic acid. As an example of the use of sodium silicofluoride, one pound of the powdered material is introduced into a tank of 100 gallons capacity, which is then filled with latex previously standardised to bring it to a dry rubber content of 2·5 lb. per gallon and the whole is vigorously stirred until coagulation is complete. Experiments are still being carried out with the new coagulant, and a supply of rubber is being despatched for trial by a manufacturer. So far the results of tests have been very favourable, but its general use is not as yet recommended.

FIBRES

Cotton

Union of South Africa.—Reference to the cotton-growing industry of South Africa is made in the Annual Report of the Department of Agriculture for the year ended June 30, 1922, which has been issued as No. 6 of the *Journ. Dept. Agric.* (1922, 5).

The crop for 1921 showed an increase over that of the previous year and a steady progression has thus been maintained as is shown by the following statistics of production for the years 1911–21:

	lb.		lb.
1911	13,623	1917	243,885
1912	32,025	1918	283,128
1913	34,471	1919	764,584
1914	71,654	1920	1,094,763
1915	215,990	1921	1,169,298
1916	227,562		

The 1922 crop, although showing a somewhat small yield per acre, will probably give a good average for the whole area planted, as but little damage was caused by insect pests. It is considered that the reported decline in the yield of cotton in the United States will encourage the development of a large industry in South Africa.

A Co-operative Cotton Growers' Exchange has been formed to arrange for the disposal of the whole crop to the mutual advantage of the growers. Several meetings were held by representatives of the cotton-growing districts in the Transvaal and Natal with a view to organising the cotton planters and establishing co-operative associations in all suitable centres, including Swaziland. In this connection, the question of grading the cotton is receiving consideration.

Competitions for certain prizes offered by the British Cotton Growing Association have aroused keen interest among the farmers and have afforded them considerable encouragement.

In view of the mixed quality of the cotton at present grown in the Union, attention is being given to the production of large supplies of pure seed for sowing, and arrangements have been made to extend the Tobacco and Cotton Experiment Station at Rustenburg by thirty acres and to appoint a plant breeder to carry on the work.

Uganda.—A Report by the Department of Agriculture, Uganda Protectorate, on the position of the cotton-growing industry has been published as a *Supplement to the Official Gazette* of October 16, 1922. A largely increased area

has been planted, the cotton plants were generally in a very promising condition at the date of the Report, and a large crop is anticipated.

The areas devoted to cotton in the various districts of the Protectorate in the years 1920–22 are estimated as follows:

	1920.	1921.	1922.
	Acres.	*Acres.*	*Acres.*
Eastern Province			
Teso District	65 000	47,000	83,971
Bukedi District	44,000	30,000	72,148
Busoga District	45,000	31,000	59,492
Lango District	26,500	20,300	35,008
Total	180,500	128,300	250,619
Buganda Province			
Mengo District	32,000	24,000	60,000
Entebbe District	10,000	6,000	10,000
Masaka District	7,000	3,000	10,000
Mubendi District	6,000	1,000	6,000
Total	55,000	34,000	86,000
Northern Province			
Gulu District	1,500	1,000	4,000
West Nile District	100	500	2,000
Chua District	500	100	1,000
Bunyoro District	1,000	500	1,500
Total	3,100	2,100	8,500
Grand Total	238,600	164,400	345,119

Ceylon.—Reference has been made in this BULLETIN (1922, **20**, 106) to experiments in cotton growing which are being made by the Department of Agriculture in Ceylon. It has been stated (*Trop. Agric.*, 1922, **59**, 137) that the encouraging results obtained in the trials at Ambalantota and the opening of a new mill at Colombo by the Ceylon Spinning and Weaving Co. have aroused considerable interest in the cotton-growing industry. Areas of Crown lands have been taken up for planting the crop and a number of trials on an experimental scale are being made on private lands.

The Department of Agriculture is prepared to supply seed to all who intend to undertake cotton growing and to give advice on methods of cultivation and the treatment of diseases and pests. A market is provided at Colombo by the Ceylon Spinning and Weaving Co. who are willing to

purchase all cotton of standard quality. The Department will supply Cambodia cotton seed to planters unless other varieties are specially desired. The work at Ambalantota is being continued and new strains of Cambodia cotton are being obtained from Madras for experiment. If necessary, a seed-farm will be established for the production of a supply of selected cotton seed.

The pink boll-worm appeared in small numbers in the second picking of the crop at Ambalantota, but the precaution was taken to burn all the stalks before the land was ploughed for the new crop.

Paper-making Materials

Papyrus.—In this BULLETIN (1921, **19**, 81) reference was made to experiments on papyrus from the Gaboon which had been carried out at the École française de Papeterie by L. Vidal and M. Aribert, who suggested that the freshly cut papyrus would possibly be more easily converted into paper-pulp than the dried material.

Experiments have now been made by the same investigators with fresh papyrus grown at the Institut National d'Agronomie Coloniale at Nogent-sur-Marne, and the results have been published in *L'Agronomie Coloniale* (1922, **6**, 234).

It was found that, contrary to expectations, the treatment was not facilitated by employing the papyrus in the fresh state. In the case of both the fresh and the dry material it was necessary to use 13 per cent. of caustic soda to obtain a pulp which could be bleached. The yield of unbleached pulp varied from 32 to 35 per cent. and that of the bleached pulp from 25 to 27 per cent., these figures being about 6–7 per cent. lower than those obtained with the dry papyrus from the Gaboon. It is considered, however, that the low yield was due to the material being somewhat immature owing to its having been grown in too cold a climate. The general conclusion drawn from this work is that it does not make any difference whether the process of digestion is carried out with freshly cut papyrus in the country of origin or with dried material in Europe.

Woods of Indo-China.—An account of the investigation by the Service d'Études des Productions Coloniales of the suitability of certain woods of Indo-China for paper-making has been published in the *Bulletin de l'Agence Générale des Colonies* (1922, **15**, 808).

Gao wood (*Bombax malabaricum*). On treatment with fairly concentrated solution of caustic soda this wood yielded 30 per cent. of a pale brown pulp which could be

easily bleached and furnished paper of good quality. The ultimate fibres ranged from 2·0 to 2·7 mm. in length and from 25μ to 40μ in diameter.

Seu wood (*Celtis australis*). This wood requires rather drastic treatment with caustic soda to effect its reduction. It yielded 34 per cent. of a pale yellowish-brown pulp which could be readily bleached and furnished a good paper of ordinary quality. The ultimate fibres varied from 1·6 to 1·8 mm. in length and from 20μ to 30μ in diameter.

Vai wood (*Pterospermum diversifolium*). This wood on being treated with caustic soda under somewhat drastic conditions yielded 40 per cent. of a pale brown pulp with a slight rose tint which could be fairly easily bleached but gave a paper of only mediocre quality. The ultimate fibres were 1·4 to 1·7 mm. long and 25μ to 35μ in diameter. The wood could best be utilised in admixture with other materials.

Vang-Chung wood (*Endospermum chinense*). This wood needed drastic treatment with caustic soda for its reduction and yielded 34 per cent. of a pale brownish-yellow pulp which could be very easily bleached and furnished a paper of silky appearance. The ultimate fibres were 1·3 to 1·7 mm. long and 30μ to 45μ in diameter. The wood could be employed for the manufacture of an ordinary paper or could be used in admixture with other materials.

Minerals

Asbestos

Switzerland.—According to *Asbestos*, December 1922, p. 35, owing to the stimulus of war conditions, Switzerland produced 411 tons of asbestos from July 1918 to April 1919. The chief deposits are at Poschiavo in the Canton of Grisons, but there are also mines at Val Moleno and Val Moiry in Southern Switzerland. The quality of the product is only medium, but a small amount of spinning fibre is produced. The whole of the raw material produced is manufactured in local mills and sold within the country.

Russia.—In the February (1923) issue of the same journal (p. 24) it is stated that the American corporation which has secured concessions to work certain Russian asbestos mines has successfully restarted the Alapaevsk mine, and at that time there were 6,400 cwts. of asbestos (including nearly 400 cwts. of first grade) awaiting shipment. Modern appliances which have been installed will make it possible to produce 32,000 cwts. of sorted asbestos during 1923. Thus, after a long absence, Russian asbestos will soon come into the market again as a serious rival to the Canadian material.

Finland.—Some information is also given in the same article on the occurrence of asbestos in Finland. At Paakkilanniemi in the S.E. part of Tuusniemi parish asbestos rock is stated to occur in lenses in serpentine and not in veins as is usually the case. The deposit was formerly worked by a Danish firm, who milled the rock and exported fibre for the manufacture of fireproof plates, but during the war this work was carried on and extended by a Finnish company.

United States.—The January 1923 issue of *Asbestos* prints a comprehensive article on the asbestos deposits of Arizona. The asbestos is chrysotile, is noted for its freedom from iron, and is therefore highly esteemed in the electrical trade. It is stated that the best grades of Arizona asbestos are as good as the best Canadian product.

Coal

Australia.—The brown coals of Victoria have been previously referred to in this BULLETIN (1921, **19**, 538). A further report by H. Herman has appeared recently (*Bulletin* 45, 1922, *Geol. Survey, Victoria*). The total production of brown coal in Victoria to the end of 1919 was 298,047 tons. Nearly all the coal obtained from 1911 to 1916 came from Altona, which produced 3,643 and 1,445 tons in 1918 and 1919 respectively. The Altona pit is at present non-productive. The output of coal from the Morwell Open Cut was quite small until the State resumed operations there in 1916. The output from that mine from 1916 to 1920, inclusive, amounted to 370,981 tons. Plans and specifications for the scheme for utilising the Morwell lignite deposit have been prepared, and tenders have been invited for plant of 50,000 kilowatts capacity.

The report is illustrated by numerous geological plans and sections; it contains descriptions and drawings of both high- and low-temperature distillation plants, and details relating to the by-products; briquetting; boiler use; pulverised brown coal; and producer gas. Appendixes contain results of gas producer tests on Morwell brown coal by Gilbert Rigg, and palæontological notes on the coal by F. Chapman, who concludes that the Morwell coal is apparently formed of many types of vegetation, including a considerable proportion of coniferous stems, which are clearly allied to, if not identical with, *Callitris*. This material, together with the half-decayed leaves, spores and seed-vessels of the undergrowth, was probably drifted into large swampy catchment areas not very far removed

from its original source. The accumulated mass of vegetation must have become consolidated under peculiarly favourable circumstances in a slowly subsiding area.

Contributions to the geology of Ipswich, Queensland, by J. H. Reid and C. C. Morton have been published recently (*Queensland Govt. Min. Journ.*, September and October 1922, pp. 355 and 390).

They consider that there is no prospect of the Aberdare or associated coal seams occurring on the west side of the West Ipswich fault. The Waterworks seam, which averages about 50 ft. in thickness, shows large outcrops in portion 161, parish of Brassall, Brisbane River, and in portion 188A, about 1 mile farther east. Reid and Morton believe it to be the continuation of Cameron's " Big " seam of the North Ipswich mining field, as they have traced it to within half a mile of that seam. The tracing of this seam to its most westerly point indicates that an area of country to the south-east, say portion 399, parish of Brassall, and thereabouts, should be underlain by the seam at an easily accessible depth, with probably only a moderate angle of dip, 20° or under. From the appearance of the outcrops, it is considered that it probably carries a workable thickness of coal, but owing to the numerous faults in the field, it cannot at present be considered a favourable proposition.

Canada.—In a geological report on the Kananaskis Lakes—Palliser River Map-Area, Alberta (*Summ. Rept.*, 1921, *Geol. Survey, Canada*, Part B, p. 91), J. R. Marshall gives a description of the coal deposits. The Kootenay formation (Lower Cretaceous) carries all the workable coal in the area examined (cf. *Imperial Institute Monograph on Coal*, 1920, p. 97), and is characterised by cross-bedded grey sandstones, dark shales and intercalated coal seams. The measures have been prospected on Picklejar Creek, and on Pocaterra Creek, and have been considerably developed on the Burns property, Sheep Creek, where the most extensive exposures of the measures may be seen.

On the Burns property a tunnel driven for 2,250 ft. across the measures cuts 12 or 14 seams, 7 of which are workable. The first of these, 1,376 ft. from the portal, is reported to be 39 ft. thick ; at 1,500 ft. there is a 21-foot seam ; and at 2,200 ft. a seam 12 ft. wide, including two thin bands of shale, was crossed. In this last seam the coal is of the lump variety, and considerably harder than the coal in the first two seams cut. The calorific value in B.T.U. per lb. of selected and channel samples of this coal

were 14,930 and 13,250 respectively. On Sharp Creek there are at least 70 ft. of workable coal. A sample from one seam, 15 ft. in width, gave a calorific value of 12,930 in B.T.U. per lb. Two seams, 10 ft. and 7 ft. in width, respectively, were observed in Picklejar Creek. A sample of coal from the 9-foot seam on the slope north of Pocaterra Creek gave a calorific value of 14,510 in B.T.U. per lb.

There are, without doubt, extensive reserves of high carbon bituminous coal within the area examined, and it is reasonable to expect that, with more intense prospecting and increased development, more and even better coal seams may be uncovered. The deposits are so situated that railway communication may be provided with little difficulty.

Copper

Japan.—The mining and metallurgical treatment of the cupriferous pyrite deposit of the Besslic mine, on the island of Shikoku, Iyo province, Japan, are described in a recent number of the *Far Eastern Review* (abstract in *Eng. and Min. Journ.-Press*, January 6, 1923, pp. 16–18). The geology of the deposit is briefly described in the *Imperial Institute Monograph on Copper Ores* (1923, p. 131). From 1691 to 1917 the mine produced 257,805 tons of refined copper. The annual output is now 233,000 tons of ore, which produces approximately 3,000 tons of refined and 11,230 tons of electrolytic copper. The Besslic refined copper contains 99·7 per cent. and the electrolytic 99·9 per cent. of copper. It is especially suitable for the manufacture of brass and is sold at higher prices than the best selected brand on the London market.

Australia.—The Mount Coolon Goldfield, Queensland, is reported on by C. C. Morton (*Queensland Govt. Min. Journ.*, November 1922, p. 425). The goldfield has an area of 45 square miles, and, with its township of Kaola, is situated on Police Creek, a tributary of the Suttor River, which drains the southern portion of the Burdekin River Watershed. The lodes appear to be confined to a narrow strip of volcanic rocks which runs along the eastern edge of granite. The lode material has all the appearance of a very siliceous felsite. According to H. I. Jensen (*Queensland Govt. Min. Journ.*, December 1921, p. 491, and January 1922, p. 7), some of the leases are in dacite and andesite, others in felsite or in felsite tuff and breccia. Felsitic dykes are also shown as occurring in the region. At a depth of 65 ft. in the Kangaroo shaft of the Sunbeam lease, the main lode, which strikes N.W. to S.E., is said to

be from 2 to 8 ft. in width and to assay from 4·8 to 46·2 dwts. of gold per ton. On the Native Bear lease, immediately to the south-east of the Sunbeam, the same lode is from 8 to 15 ft. in width, and has been worked to water level, or to a depth of 100 ft. Pyrite occurs in greater quantities at this level, and garnet (andradite) is also present as an associate of the ore at the south-east end of this level. From January 1921 to July 1922, 3,457 tons of ore crushed from this lease yielded 2,173 oz. of gold, equal to 12½ dwts. per ton, without including the return from the tailing. On the Sydney claim, between the last and the Coolon lease, the main lode averages 5 ft. in width. The clean-up at the battery in May 1922 yielded 120½ oz. from 105 tons of ore, or about 23 dwts. per ton, the gold recovered from the sand not being included. In the Coolon lease the main lode is from 7 to 10 ft. in width, and has been proved to a depth of about 100 ft. The mill on the property has crushed 490 tons of ore, which yielded 454 oz. of gold, or about 18½ dwts. per ton, without including that from the sand.

Hitherto, nothing of great importance appears to have been found in the remaining leases.

The new St. Ives Goldfield, Western Australia, has been reported on by R. C. Wilson (*Chem. Eng. and Min. Rev.*, October 5, 1922, pp. 27–28). St. Ives is nearly 50 miles S.S.E. of Kalgoorlie.

On the Ives Reward lease there are two well-defined lodes or mineralised dykes which strike W. of N. and dip E. The ore-body at 69 ft. in depth is 36 ft. wide. Various samplings have shown from 10 to 17 dwts. of gold per ton. A crushing of 231 tons from this level averaged 15 dwts. of gold per ton. At a depth of 119 ft., the lode, which contains much pyrite at that point, was 27 ft. wide and gave 12½ dwts. of gold per ton. At the 65-foot level in the No. 4 shaft, the lode is 21 ft. wide and averages 21 dwts. of gold per ton. In the No. 2 shaft, the Blue lode, 12 ft. in thickness, of a jaspery nature, is exposed in the cross cut at the 73-foot level. A winze was sunk 35 ft. on this, at the bottom of which the lode is 9 ft. wide and averages 10 dwts. of gold per ton.

On the Ives Reward Junction lease, the No. 2 shaft, which is 90 ft. deep, shows a lode 6 ft. thick, assaying 11 dwts. of gold per ton. A north drive, 61 ft. in length, shows ore carrying 16 dwts. of gold per ton for a width of 77 in. The present face is worth only 1·5 dwts. per ton. Assays of other portions of the workings vary from 3½ dwts. to 8½ dwts. of gold per ton. On the Cross Reef, which dips N.W. 50°, a shoot of ore 20 ft. in length was stoped

to a depth of 40 ft., and yielded 10 tons worth 5¼ oz. of gold per ton. The gold was practically confined to a small leader a few inches wide on the hanging-wall. Some rich ore has also been obtained from the Cooee and New Victory leases.

Canada.—The gold-bearing quartz veins of Barkerville, Cariboo District, British Columbia, are described by W. G. Uglow in *Bulletin* No. 127, November 1922, *Canadian Inst. Min. and Met.*, p. 1165.

Barkerville is situated 58 miles east of Quesnel, on the bank of the Fraser River. The Cariboo or gold-bearing series of sedimentary rocks consists of quartzite or quartz-slate, sericite-schist, black slate and fine-grained blue-grey limestone. The quartz veins occur in the quartzite chiefly, especially in the more thinly-bedded schistose portions. They are of two types and are termed "A" and "B" veins by Uglow. The "A" veins, usually large bodies of white quartz up to 100 ft. in width and of unknown length, are especially prominent in a broad band of shearing, which trends N. 35°–40° W., from ¼ to 1 mile or more in width, and more than 25 miles in length. These veins are abundantly intersected by crossing closely spaced fractures, so that the quartz is very friable, and has a tendency to break into plate-like pieces. The veins, which are of pre-schist origin, are in places impregnated with pyrite, which carries only a low content of gold. The "B" veins strike N.E., and are narrow, varying from a few inches to 2 ft. in width. The quartz of these veins is massive and unsheared, and the margins of the veins are characterised by narrow comb-like bands of siderite and ankerite, which are weathered to a yellow or dark brown colour near the surface. The veins are usually well mineralised with galena, pyrite and arsenopyrite, with minor amounts of blende, barytes and scheelite. The sulphides carry high gold contents in many places; the veins, however, are too thin to be mined separately but may be of economic value when several veins occur closely spaced, as, for example, on the Victory claim. The unoxidised portions of the veins exhibit cavernous honeycombed quartz from which pyrite crystals have been leached, and, in many cases, coarse crystalline gold has been found in these cavities. The "B" veins are post-schist in origin, and cut across the foliation of the schistose quartzites, and cut through and meet the "A" veins, which are impregnated near the intersections with the group of sulphides mentioned above. Definite shoots of ore of fair size are to be expected at these points. For instance, on the

Black-Jack property, a belt of "A" veins is intersected by a large number of mineralised cross-fissures of the "B" type, which have formed a well-defined shoot. In a width of 50 ft., 25 mineralised cross-stringers, from 2 to 10 in. in thickness, were counted. Gold to the average value of \$17·71 per ton was obtained from 202 tons of ore raised from the 42-foot level in this claim. Again, on the Independence-Kitchener, the "A" quartz, near its intersection with veins of the "B" type, is heavily mineralised with arsenopyrite, foliated galena and pyrite.

The intersections may prove of economic importance, and any future exploration in the district should proceed by the methods of locating them and sinking on them.

Mica

Austria.—A report is published in the *Mining Journ.* (July 29, 1922, p. 585) stating that extensive deposits of mica have been found in Styria and Carinthia and are now being worked. The mica is of suitable grade for electro-technical purposes and great interest is being taken in it by the German manufacturers, since they have lost control of the East African deposits.

Canada.—A. E. Cameron gives the results of the exploration of Hay and Buffalo rivers, Great Slave Lake, and adjacent country in the North-West Territories (*Summ. Rept.*, 1921, *Geol. Survey, Canada*, Part B, p. 1). One of the main objects of the exploration was the determination of the possibilities of an oil-field near Great Slave Lake (cf. *Imperial Institute Monograph on Petroleum*, 1921, p. 34). Several wells have been sunk on the Athabaska and Peace River districts to the south, though with little success. In 1917 the McArthur well No 2, sunk near the town of Peace River, struck strong gas flows, and obtained a production of about 9 barrels of heavy oil a day. The oil appears to come from a horizon in the Cretaceous, not far above the Devonian. On the shores of Great Slave Lake the outcropping limestones (Upper Devonian) are more or less bituminous, and some on fracture give a distinct seepage of heavy petroleum.

At Nintsi Point the massive-bedded Presqu'île dolomite (Middle Devonian) is highly impregnated with oil. The rocks are badly fractured and fissured and show distinct evidence of local doming. Tar and oil pools occur along the fissures and bedding planes, and cold-water sulphur-springs are numerous in the vicinity of the oil seepages. Cameron is of opinion that the oil seepages at Nintsi Point are due partly to local and partly to deeper structural

conditions. The Presqu'île dolomites appear to be the principal oil-bearing horizon, and as these are exposed at the surface on the limb of the anticline the possibilities of an oil-field of great value near the lake are but slight. Underlying the dolomites are the Pine Point series of limestones and limy shales (Middle Devonian), which appear to be sufficiently compact to act as a capping over any possible oil-bearing horizon existing below, but the sediments underlying the Pine Point series on the north shore do not appear likely to contain oil, although the immediately underlying Fitzgerald dolomitic limestones (Silurian) are somewhat porous. The Presqu'île dolomites are the best container for oil, and if an impervious capping can be found overlying these in a district structurally suitable, the condition would warrant exploration with the drill. Hay River gives an excellent section through the sediments overlying the dolomites. This section shows 790 ft. of shaly material, which would prove an ideal capping for an oil-field. The well drilled at Vermilion chutes was flooded by salt-water and abandoned at 850 ft. before penetrating the Middle Devonian sediments. It is to be regretted that it was found impossible to continue the well to greater depths. Another 200 or 300 ft. might have penetrated the dolomites and proved the value of that horizon as an oil container at this locality.

United States.—O. W. Freeman contributes an article on petroleum in the Quadrant formation in Montana (*Eng. and Min. Journ.-Press*, May 13, 1922, pp. 825–827). The Quadrant formation is of Carboniferous or Permo-Carboniferous age, and is found beneath beds of Jurassic age; above the latter lies the Kootenai formation, of Lower Cretaceous age. Oil was first discovered in Montana in the Quadrant formation of the Devil's Basin, about 15 miles north of Roundup, in November 1919. A few months later the important Cat Creek field, 60 miles east of Lewistown, was discovered, and in March 1920 oil was struck 40 miles south of Hardin, in the Soap Creek field. The oil of Cat Creek comes from the top sand and the lower or Lupton sand of the Kootenai; the oil of Soap Creek comes from near the base of the Quadrant. At present there are over 70 producing wells at Cat Creek, 5 at Soap Creek, and 2 in the Devil's Basin. Of these Cat Creek is the only locality served with a pipe line. The oil of Soap Creek and Devil's Basin is heavy and black, low in gasoline and high in lubricating oil. The oil of Cat Creek is not a normal oil; it consists of over one-half gasoline, has neither a paraffin nor an asphaltic base, and

contains scarcely any lubricating oil. Cat Creek is a region of faulting, and, according to Freeman, it is highly probable that the oil from the Quadrant, and possibly from other formations, migrated upward through the faults until the sands of the Kootenai were reached. Further migration would then be prevented by the impervious Colorado oil-shale that overlies the top sand of the Kootenai. During the migration the petroleum would be altered and fractionated by filtering through strata of different character. The Quadrant formation is extremely variable, both in thickness and in the character of the rocks composing it ; nevertheless, it is highly desirable that it should be thoroughly tested at Cat Creek ; this could be done with a well about 3,000 ft. deep, and the discovery of a large deposit of black low-grade oil would probably result. The most favourable sites to test the Quadrant would be between the Yellowstone River and the Big Horn Mountain, and around the mountain uplifts in central Montana.

Precious Stones

Gold Coast.—In the *Report of the Geological Survey, Gold Coast*, 1921, it is stated that two diamonds were found by officers of the survey in the gravels of the Yaw Yaw Su, about 11 miles north of Enchi. These, which are very good stones, are the first diamonds discovered in the Western Province of the Colony.

Australia.—A note by E. C. Saint-Smith in the *Queensland Govt. Min. Journ.* (May 15, 1922) describes the occurrences of opal in the Springsure District, Queensland. Although precious opal has long been known to occur in this district, renewed interest in the locality has been aroused by recent prospecting and the taking up of large claims at Murray's Pinch. The opal occurs in vesicles in basalt but the precious variety is comparatively rare. The author is of opinion that, owing to the rarity and the small size of the gems so far discovered, the occurrence will never become of great importance although accidental finds of great value may be made from time to time. Also it is to be noted that opal occurring under similar conditions elsewhere has frequently been found to lose its beauty and stability on exposure to the air, thus rapidly becoming valueless.

British Guiana.—The *Report of the Lands and Mines Department, British Guiana*, 1921, mentions the diamond boom in that colony. The stones, which have all been obtained from alluvial workings, are of good quality,

but, although generally small, some large ones have been found, one weighing over 29 carats. The chief producing area is the Mazaruni field extending from Tiboku Falls up to Peima Falls, including all the tributaries of the Mazaruni River and the upper Puruni River. The scene of the present boom is Tacouba Creek, a tributary of the Kurupung River, where in places as much as 100 carats of diamonds have been obtained per cubic yard of gravel. The diamonds occur in gravels which were derived from a conglomerate consisting almost entirely of variously coloured quartz pebbles, and are associated with tourmaline, ilmenite, ferro-magnesian silicates and gold. The primary source of the diamonds is considered to be, as in Africa, a series of volcanic pipes, but so far no such rocks have yet been discovered. The drawback to effective development of the country's mineral resources is lack of transport, all machinery and stores having to be carried inland by small boats.

Silver

Canada.—The silver-copper deposits of the Bridge River Map-Area, British Columbia, are described by W. S. McCann (*Memoir* 130, 1922, *Geol. Survey, Canada*, p. 71). The vein outcrops are 8,000 ft. above sea-level, and the climate is such that the deposits cannot be worked for more than five months in the year. The deposits occur in a well-defined quartz vein, striking nearly E.-W. with the enclosing Bridge River series (Pennsylvanian-Permian), and dipping S.70°. For a great part of its length the vein follows the contact between the cherty quartzites of the series and a small serpentine belt, its direction being roughly parallel to the southern contact of the Bendor quartz-diorite batholith, which lies half a mile to the north. The vein is closely associated with a quartz-diorite porphyry apophysis of the Bendor batholith. It is traceable for over a mile, has a banded structure, and averages 7 ft. in width, although there are local swellings which measure 32 ft. in places. The gangue is quartz which contains tetrahedrite sparsely distributed through it, and small amounts of galena. The two former minerals are contemporaneous, but the galena, which is argentiferous, occurs only along the plane caused by the sheeting of the vein. Microscopic examination shows that the quartz containing the galena has been extremely shattered and crushed.

The ore minerals are irregularly distributed through the vein, large parts of which are barren. When tetrahedrite forms 3 per cent. of the vein, the silver content

is low and the gold content high. A sample at the Empire No. 1 claim assayed 35·2 oz. of silver and $0·40 of gold per ton; another gave 35·4 oz. of silver per ton and 0·5 per cent. of copper. Two other samples gave little silver and only traces of gold and copper.

Sulphur

Persia.—In the *Geol. Survey, India* (1922, **53**, 343) the sulphur deposits of South Persia are described by Dr. G. E. Pilgrim. These are situated chiefly near Bostanah (near Lingah); near Khamir; on Qishm Island; and near Kirmusteh. The last-mentioned deposit, which is stated to be the purest and greatest of all, was not examined, owing to its location in country infested with brigands. The Bostanah (near Lingah) deposits occur in five areas about 1½ miles from the sea, and the sulphur is confined to the vicinity of a vertical fault which thrusts beds of the Hormuz series (Jurassic) over beds of Fars age. It is associated with much gypsum. Three of the deposits together are estimated to contain about 380,000 tons of sulphur ore, the free sulphur content of which varies from 10 to 33 per cent. There would be difficulties in the way of exploiting these deposits commercially owing to the absence of water and fuel in the neighbourhood, but the ore could readily be brought down to the sea by aerial ropeway.

The deposits near Khamir were extensively worked some 25 years ago. They are situated about 3½ miles from the shore, at the edge of the foothills, and again follow the line of a fault between Hormuz and younger beds. Here it is estimated that there are about 100,000 tons of ore in sight, averaging about 12 per cent. of sulphur, although picked samples gave nearly 40 per cent. The situation of the ore would render the working of it a very difficult matter.

The deposit on Qishm Island is of small extent, and besides being of poor quality is very inaccessible.

Other deposits were visited at Bostanah (15 miles W. of Bandar Abbas) on Hormuz Island, near Latidun, and at Ginau, but these were all of extremely small extent.

In the event of attempts being made to exploit these deposits, the author advises that the Bostanah (near Lingah) deposits would present the fewest difficulties.

Talc

Canada.—In *Publication* No. 583, 1922, *Canadian Department of Mines*, H. S. Spence describes the talc and soapstone deposits of Canada. Hitherto Canada has produced

only the ground product, chiefly derived from the cream-coloured foliated talc mined in the Madoc and Eldorado districts of Hastings county, Ontario, where it occurs as an alteration product of Pre-Cambrian magnesian limestone, but in the present report the author describes a very promising occurrence of the massive mineral. This is situated near Wabigoon Lake, Kenora District, Ontario, and lies within 500 yards of the Canadian Pacific Railway. The Wabigoon stone is a dark grey-green rock largely composed of talc with some chlorite and dolomite, closely resembling the Alberene stone mined on a large scale in Nelson, Virginia, and used in slab form for a great variety of purposes. The rock is massive, homogeneous, and of uniform fine to medium grain, but with phenocysts of dolomite up to ⅛-inch diameter. The observed outcrops show the existence of two well-defined bands separated by about 100 feet of altered diorite, the northern band being about 500 ft. long by 35 ft. wide and the southern probably much larger, so that there is a large tonnage of material available.

A number of tests were carried out on samples of this stone taken from quite near the surface, and these, which included tests for crushing strength, transverse strength, corrosion, absorption and fusion, gave highly satisfactory results as compared with the Virginian stone mentioned above. Spence suggests that the stone could readily be used for bricks for the incineration furnaces of sulphate pulp (kraft) mills, which are at present imported into Canada from the United States. It might also be used for bake ovens, and for electrical and numerous other purposes. This deposit is the most promising, from an economic standpoint, of any of the soapstone occurrences mentioned in the publication.

It is announced in the *Eng. and Min. Journ.-Press*, December 16, 1922, p. 1071, that a company has been formed to work these deposits on a commercial scale.

NOTICES OF RECENT LITERATURE

HANDBOOK OF NYASALAND. Compiled by S. S. Murray, Chief Clerk, Nyasaland Government. Pp. 314, 8vo, 8¾ × 5¾. (London: Crown Agents for the Colonies; Zomba, Nyasaland: Government Printer, 1922.) Price 5*s*.

In a Prefatory Note the compiler of this work indicates that it was at first intended to revise the second edition of the Handbook issued in 1910, but that, as so much of that edition was found to be out of date, inadequate, or otherwise unsuitable for reproduction, it was felt to be more convenient to rewrite the entire Handbook on different lines. The result abundantly justifies this decision. Mr. Murray has presented the reader with an excellently arranged, up-to-date, clearly printed and most informative Handbook, and it is difficult to imagine any class of reader interested in Nyasaland who would not profit by its perusal.

The information given, which is supplemented by a map and a number of photographs, has been supplied by Government officers, scientific experts, missionaries, and others familiar with the subjects dealt with, and the work forms a clear and authoritative presentation of the history, geography, ethnology and economic conditions of the country. In addition to the chapters devoted to social and administrative matters and those giving detailed accounts of the separate Provinces, there are sections relating to agriculture, trade and commerce, lands, mines and forests, zoology, climate, missions and education, and other subjects, and the volume ends with a chapter giving practical information and advice to those who contemplate visiting or residing in Nyasaland. Among the products specially dealt with in the section on Agriculture are cotton, tea and tobacco. If the efforts to produce the types of tobacco required on the English market and to avoid the shipment of low-grade leaf are continued, there is no reason why tobacco growing should not become an even more important industry than at present.

The Handbook contains much to interest the general reader who has no special connection with the Protectorate. Many will be surprised to learn of the variety of races and languages to be found in this small country, which is wedged in between Rhodesia and Portuguese East Africa and is for this very reason of considerable political importance. Particulars are furnished of the part played by the country in the late war, when the native adult males, estimated at only 250,000, furnished some 19,000 combatant soldiers, whilst no less than 191,000 served

in one way or another as auxiliaries in the campaign, notwithstanding the need for keeping up the food supply for the native population of over a million. The natives could have only imperfectly understood the cause for which they fought, but it was a case of rendering devoted service to a Government which they loyally respected.

HANDBOOK OF COMMERCIAL AND GENERAL INFORMATION FOR CEYLON. Compiled by L. J. B. Turner, M.A., of the Ceylon Civil Service. Pp. x + 260, 8vo, 8¾ × 5¾. (Colombo: Government Printer; London: Crown Agents for the Colonies, 1922.) Price Rs. 10.

This Handbook, arranged on similar lines to that for Nyasaland described above, deals with a much better known part of the Empire and may therefore attract a larger number of readers. To all those concerned with the Colony as visitors, planters, traders, etc., the work can be strongly recommended as a useful compendium of facts and figures. Several good maps and a series of photographs illustrating the agriculture and industries of the country add to the value of the book, the various sections of which have been contributed or revised by Government Departments and thus furnish a reliable account of the Island and its resources. The volume contains many useful diagrams and statistical tables, whilst information is given regarding industrial operations, such as the collection and preparation of rubber, the extraction of coconut oil, and the preparation for the market of tea, cocoa, cinnamon and tobacco. In an account of the somewhat limited mineral resources of the Colony, reference is made to the occurrences of thorianite and monazite discovered by the Mineral Survey carried on for many years in collaboration with the Imperial Institute—where the commercial value of these deposits was demonstrated and assistance given in connection with their exploitation.

A useful section for those concerned in the trade of Ceylon is that devoted to the laws of the Colony and the applicability of English law in certain matters. Particulars are also given in the Handbook regarding harbours, railways and roads, canals, and steamboat and postal services. As a work of reference the volume is both practical and comprehensive, and it should have a wide circulation in the Colony and outside.

THE COTTON-GROWING COUNTRIES: PRODUCTION AND TRADE. Compiled by the Statistical Bureau of the Inter-

national Institute of Agriculture. Pp. xxiv + 147, 8vo, $9\frac{3}{4} \times 6\frac{3}{4}$. (Rome: International Institute of Agriculture; Manchester: John Heywood, Ltd., 1922.) Price 5*s*.

In view of the importance of increasing and improving cotton production in all parts of the world and of providing accurate statistical information, the International Institute of Agriculture prepared a questionnaire, asking for statistical data and other particulars covering the last ten years on the following points: (1) area and production; (2) dates of planting and picking; (3) particulars of production, including species and length of staple; (4) consumption in the producing country; (5) imports and exports; (6) particulars of the growing crops. This questionnaire was sent to the Governments of 79 countries and 41 were returned with the fullest information available.

The information thus obtained has been embodied in the present monograph, and other particulars have been added which have been collected from the various Governments or obtained from other trustworthy sources. The countries are dealt with in the following order:—*Europe*: Bulgaria, Greece, Italy, Malta. *America:* Argentina, Brazil, Colombia, Ecuador, Guatemala, British Guiana, Dutch Guiana (Surinam), Mexico, Nicaragua, Paraguay, Peru, United States, Venezuela, and the West India Islands, including Antigua, Barbados, Dominican Republic, Grenada, Hayti, Martinique, Montserrat, Porto Rico, St. Eustatia and St. Martin, St. Kitts, Nevis, Anguilla, St. Vincent, Trinidad and Tobago, Turks and Caicos Islands, and the Virgin Islands (American and British). *Asia:* Afghanistan, Ceylon, China, Cyprus, Dutch East Indies, India (British), Indo-China, Japan, Korea, Persia, Russia (Asiatic), Siam, Syria, Turkey-in-Asia (Cilicia). *Africa:* Algeria, Angola, Belgian Congo, Egypt, Erythrea, French Equatorial Africa, French West Africa (comprising Dahomey, French Guinea, Ivory Coast, Senegambia, and the French Sudan), Gold Coast, Kenya, Mozambique, Nigeria, Nyasaland, Rhodesia, Somaliland (Italian), Sudan (Anglo-Egyptian), Tanganyika, Togo (British and French), Uganda, Union of South Africa. *Australasia:* Queensland, New Caledonia and New Hebrides.

In the case of each country information is given as far as possible on the following points: (1) authorities quoted; (2) statistics of area and production; (3) principal districts in which cotton is grown; (4) dates of planting and picking; (5) details as to areas under cultivation; (6) details as to production, including character of staple, botanical and trade designations, and any special characteristics; (7) pests and diseases by which the cotton

plants are attacked; and (8) employment of the produce, including local consumption and manufacture, exports and imports.

An appendix to the monograph contains a series of statistical tables, extracted from the International Yearbook of Agricultural Statistics, 1909–21, published by the International Institute of Agriculture.

The work gives a very useful summary of the present position of cotton growing in the various countries and includes particulars of the industry in several parts of the world regarding which but little information was previously available. It has been carefully compiled and will be of great value to all who are concerned in the production and commercial distribution of cotton.

Die Ölpalme an der Ostküste von Sumatra. By Dr. E. Fickendey. Pp. ii + 47, 8vo, 6 × 9. (Berlin: Kolonial-Wirtschaftliches Komitee, 1922.) Price 1*s.* 9*d.*

This pamphlet gives an account of the oil-palm plantation industry which has now become firmly established on the East Coast of Sumatra (cf. this Bulletin, 1920, **18**, 209; 1922, **20**, 481).

After a short historical introduction, the author proceeds to deal with the cultural conditions, including climate, soil, labour and other factors. This is followed by observations on the varieties of oil-palm occurring in the plantations, selection of the seed, treatment of the seed before sowing, seed-beds, preparation of the ground, transplanting, spacing, inter-crops, weeding, cover-crops, manuring, cultivation and harvesting, artificial pollination, yields, and pests and diseases.

A list of the Dutch literature on the oil-palm is appended.

The Forest Officers' Handbook of the Gold Coast, Ashanti and the Northern Territories. By T. F. Chipp, M.C., B.Sc., F.L.S., Deputy Conservator of Forests. Pp. vi + 106, with 4 maps and 20 plates, 8vo, 10 × 6½. (London: The Crown Agents for the Colonies, 1922.) Price 10*s.*

Comparatively little authoritative information is available regarding the forests of British West Africa and their botanical composition. As regards the Gold Coast, Mr. H. N. Thompson's *Report on the Forests of the Gold Coast*, published by the Colonial Office in the series of Miscellaneous Reports, has been the most important

publication and the source of much that has been written on the subject since its appearance in 1910. Unfortunately, that useful report has been out of print for several years, and a reprint, or the publication of a new work bringing the report up to date, has long been needed by those interested in the Gold Coast forests and their resources. Major Chipp's handbook, therefore, is welcome at a time when increasing attention is being given to the forest resources of the Gold Coast.

The subject-matter of the book, and its arrangement, have been determined chiefly by the primary object of the author to provide a convenient handbook for the officers of the Gold Coast Forest Service, but a liberal view of the requirements has been taken in order to render the volume of use to all interested in the future welfare of the forests and the factors upon which action taken in connection therewith must depend. The author, therefore, has endeavoured to bring together all available information relating to the present position of the Gold Coast forests and their special problems, and in addition has published for the first time certain original work, notably a series of observations regarding the relation of the forests to the prevailing meteorological conditions and physiography of the country.

In introductory chapters the author gives a general account of West African forests as a whole, based chiefly upon the observations of M. Auguste Chevalier, and also an account of the natural features and geology of the country in which the published work of Mr. A. E. Kitson is largely quoted. A short chapter on the ecology of the Gold Coast forests and their botanical composition is followed by estimates of the area of the forests and their annual increment. The total area regarded as "forest" is computed at roughly 28,000 square miles in a country of 80,000 square miles. Large deductions must be made, however, to allow for the area required to maintain the native farms for the production of local foodstuffs, and also the area under cocoa, as well as that needed for the supply of fuel to the mines and railways. This leaves a balance of 17,000 square miles of available forest country, but of this over 5,000 square miles comprise swamp forests and forests of no immediate exploitable value, resulting in a final residue of not more than 11,400 square miles of merchantable forest. The reservation of these forests is clearly a matter of great importance.

Notes are given on the climate and its relation to forest distribution, illustrated by graphs, maps and statistical tables; and a brief statement of the principal exports

obtained from forest sources during the last twelve years is accompanied by useful lists of trees and plants of economic importance, while a chapter is devoted to lists of native names of the principal trees. There is also a "Synopsis of Natural Orders," and a numerical statement of the number of genera and species hitherto recorded, these features being abstracted from two well-known pamphlets of the author published in 1912 and 1914 respectively. The book contains a statement of the official Ordinances and Rules governing forestry in the Gold Coast; it is claimed that the misprints in the spelling of botanical names in the original text of the Ordinances have been corrected, but there are still several corrections required in the lists of names as now printed. There are also useful notes on outfit and life in the country. The coloured maps (including one illustrating the distribution of the different types of forest) are a useful feature of the book, which includes a reprint of the excellent series of line drawings of botanical details of important trees which appeared in Mr. Thompson's Report.

SCHLICH'S MANUAL OF FORESTRY. VOL. I, FOREST POLICY IN THE BRITISH EMPIRE. By Sir Wm. Schlich, K.C.I.E., etc. Fourth Edition, revised and enlarged. Pp. xl + 342. (London: Bradbury, Agnew & Co., Ltd., 1922.) Price 15*s*.

This volume, described as a revised and enlarged edition of the first part of the "Manual," is virtually a new book and one that will perform a valuable service to foresters throughout the Empire. As is well known, the third edition comprised an exposition of the general foundations of forest policy, together with the first formal statement of the position of forestry in the British Empire so far as information on that subject was then available. Since that time (1906) the most significant event in imperial forestry has been the summoning of the Imperial Forest Conference in 1920, held in London in conjunction with the Empire Timber Exhibition, when the situation as regards forest conservancy in the different countries of the Empire was carefully reviewed in the light of a series of some thirty-four "Statements" in which the latest information on the subject was set out by the forest officers of the respective countries.

In the present volume, Sir Wm. Schlich has utilised the mass of new information contained in these statements as the basis of his account of Empire forestry, recording in a geographical arrangement all the essential facts presented to the Conference, and adding as regards each

country his personal opinions as to the measures that should be taken in the immediate future to advance the objects in view. The information contained in the first part of the book, dealing with the principles governing the foundation of forest policy—including the utility of forests, the factors of forest production, and the State in relation to forestry—is in many respects substantially as in the corresponding sections of the previous edition, though its value has been enhanced by a complete recasting and revision. The book therefore stands as a convenient summary of the position of Empire forest conservancy in 1920, and of the principles upon which its advancement depends.

It is to be hoped that the desire of the author to issue the book fully illustrated (rendered impossible by present high costs) will be realised in the next edition. Many useful outline maps and diagrams, as well as some illustrations, are, however, included in the volume. A slight blemish is a number of typographical errors in botanical names which have escaped notice in proof-reading.

RECENT PROGRESS IN RUBBER CHEMISTRY AND TECHNOLOGY. By P. Schidrowitz, Ph.D., F.C.S. Pp. 64, 8vo, 7×4½. (London: Benn Bros., Ltd., 1922.) Price 3*s*. 6*d*.

In this short review of the recent advances in rubber technology the first chapter is concerned exclusively with those belonging to the rubber plantation. Slab rubber is dealt with comparatively fully, while selection of seed, the nature of the seed oil, tree diseases, improvements in tapping, the relative characters of sheet and crêpe, and the causes of variability in time of vulcanisation are touched on. The rest of the book treats of vulcanisation, compounding ingredients and the properties of vulcanised rubber. The book is well written and affords a clear summary of the advances made during the last decade.

THE ANALYSIS OF RUBBER. By J. B. Tuttle, American Chemical Society, Monograph Series. Pp. 155, 8vo, 9¼ × 6¼. (New York: The Chemical Catalog Company Inc., 1922.) Price $2·5.

There are so many possible compounding ingredients in commercial vulcanised rubber articles that to condense all the information on their analysis into a small volume is not an easy task. Mr. Tuttle's book has only 57 pages

dealing directly with rubber analysis, and some of these are devoted to methods which the author states to be untrustworthy. Consequently the most important parts of the book are very compressed.

In addition to the section on rubber analysis there are sixty-three pages of introductory matter giving a brief account of raw rubber, of some of the compounding ingredients used, and of the methods and theories of vulcanisation. There is a useful bibliography at the end of the book and this is followed by two appendixes, one dealing with the preparation of material for rubber manufacture and the other with methods of making physical tests.

There are two points raised by the author which are of special interest to plantation rubber chemists. He states that the use of the rubber-sulphur mix as a standard for rubber testing is open to serious objections and he proposes in its place the following mix: rubber, 90 per cent.; hexamethylene-tetramine, 0·5 per cent.; sulphur, 4·5 per cent.; zinc oxide, 5·0 per cent. Since the publication of this book, however, it has been shown at the Imperial Institute (Martin & Davey, *Journ. Soc. Chem. Indust.*, 1923, **42**, 98T) that this mix will develop wide differences between rubbers which in the ordinary course of events the manufacturer would find to be quite similar. The other point is that the author states that dumb-bell-shaped test pieces are superior to ring-shaped, in spite of the fact that the latter form is used almost exclusively.

THE REIGN OF RUBBER. William C. Geer. Pp. 344, 8vo, 8 × 5½. (New York: The Century Co., 1922.) Price $3.

This book is a popular account of the history of rubber from the time of its discovery down to the present day. In addition, short descriptions are given of processes involved in the manufacture of a large number of rubber articles. The book is written in a popular style and is full of interest not only to the casual reader but also to the manufacturer, and will be invaluable to the planter who wishes to know something of the further treatment of rubber after it leaves the plantation.

PHYSICAL AND CHEMICAL EXAMINATION OF PAINTS, VARNISHES AND COLOURS. By Henry A. Gardner, Director, Scientific Section, Educational Bureau, Paint Manufacturers' Association of the United States. Pp. 220, 8vo, 9 × 6½. (Published for the Paint Manufacturers'

Association of the United States by P. H. Butler, Washington, D.C., 1922.) Price $9.

In this volume an attempt has been made to outline the more important physical and chemical tests with which every worker in a paint and varnish laboratory should be familiar. In addition to the well-known methods used, including the more important of those adopted by the American Society of Testing Materials, a number of other methods are described which have not been published previously.

Many pages are devoted to the testing of the physical properties of pigments, such as the hiding power, gravity, fineness, oil absorption and texture. The viscosity and colour of varnishes are also dealt with, whilst the remainder of the book deals with exposure tests on paints and varnishes, and the analysis and examination of paint oils, varnishes, driers, thinners, varnish gums and the various pigments.

Bound up in the volume are copies of eighteen of the *Circulars* issued by the United States Bureau of Standards in which are set out the Government specifications for many of the materials employed in the paint and varnish industry, together with details regarding their sampling and examination in the laboratory.

The book is printed in clear type and the text figures and the plates are well reproduced. It should prove of considerable value to those engaged in the paint and varnish industries.

FLAVOURING MATERIALS: NATURAL AND SYNTHETIC. By A. Clarke, F.C.S. Pp. xxi + 166, 8vo, 7½ × 5. (London: Henry Frowde and Hodder & Stoughton, 1922.) Price 8*s*. 6*d*.

This work has been compiled with the object of providing information on flavouring agents for those engaged in the manufacture of foodstuffs and beverages.

In an introductory chapter, a brief account is given of the physiology of the senses of taste and smell, and reference is made to the investigations which have been carried out with a view to the correlation of the taste and smell of chemical compounds with their chemical constitution.

The book is divided into four sections, dealing with the following subjects: (1) spices, condiments and miscellaneous vegetable and animal flavouring agents; (2) essential oils; (3) floral, fruit and compounded flavours; and (4) odorous chemical products.

In the section on the spices, a short description of the

origin and characters of each is supplied, together with reference to the analytical standards of the United States and those of the British Pharmacopœia and particulars of the distinctive microscopical features of the ground material. Analytical constants are also given of the chief substances employed as adulterants of spices and condiments. Methods of analysing spices are briefly indicated, numerous references being made to the original literature. The chapter on miscellaneous flavouring materials comprises a large number of products, including such substances as aloes, angostura bark, arnica, burdock, centaury, colocynth, dandelion, gentian, guaiacum wood, rhubarb, senna, simaruba bark, tansy, valerian and yarrow, together with more usual flavouring agents, such as anise, fennel, garlic, hops, juniper berries, lavender flowers, liquorice, marjoram, orris root, peppermint, quassia, thyme, tonquin bean, vanilla, wormwood, ambergris, civet and musk.

The section on essential oils deals very briefly with the methods of preparation and analysis, and with the sources and usual constants of all the more important of these substances, the oils being arranged under the natural orders of the plants from which they are derived.

The third section describes generally the extraction of floral perfumes by volatile solvents and also by non-volatile solvents ("enfleurage" methods) and gives special information regarding certain flowers, viz. carnation, cassie (*Acacia Farnesiana*), heliotrope, hyacinth, jasmine, jonquil, lily of the valley, rose, tuberose, and violet. It also indicates the methods of preparing fruit juices and syrups, and natural fruit aromas or aroma oils. A few recipes are given for compounded flavours, including bitters, bouquet essences, cake flavours, floral flavours, fruit flavours, herbal beverage extracts and liqueur essences.

In the final section, the characters of the odorous chemical compounds are described under the headings of alcohols and phenols, aldehydes, esters and other odorous substances.

The subject matter of this book is so wide that it obviously could not be dealt with in any great detail in the space available. Nevertheless, the information provided is well and concisely arranged and will form a useful guide to those for whom the work is intended.

OPTICAL METHODS IN CONTROL AND RESEARCH LABORATORIES. VOL. I, SPECTRUM ANALYSIS, ABSORPTION SPECTRA, REFRACTOMETRY, POLARIMETRY. By J. N. Goldsmith, Ph.D., M.Sc., F.I.C.; S. Judd Lewis, D.Sc.,

F.I.C., Ph.C.; and F. Twyman, F.Inst.P. Second Edition. Pp. iv + 56, 8vo, 9½ × 6. (London: Adam Hilger, Ltd., 1922.) Price 1s. 6d.

This volume, which is published by a well-known firm of scientific instrument makers, deals in an interesting and instructive manner with the different optical methods and instruments now employed in connection with physico-chemical investigations. The first half of the book is occupied by spectroscopy, and sets forth its value in metallurgical analysis, in determining the constitution of organic compounds, in bio-chemistry and in the standardisation and analysis of dyes, etc. The various types of instruments used, which include spectrometers, spectrographs and spectrophotometers, are described together with the methods of their technical application. Types of refractometers are then discussed, such as the Abbé, Dipping, Pulfrich and Rayleigh interference refractometers, and the class of work for which each instrument is especially adapted. The concluding chapter on the polarimeter is practically a reproduction of a contribution by two of the present authors to Glazebrook's *Dictionary of Applied Physics*, and embraces the subject from its earliest beginnings to its latest applications.

The book contains a few diagrams and tables, and three photogravure plates representing spectrophotographs.

Colour Index. Edited by F. M. Rowe, D.Sc., F.I.C. Part I. Pp. 24, 4to, 12½ × 10. (Bradford: Society of Dyers and Colourists, 1922.) Price, of complete work in 12 monthly parts, £4 4s.; bound in cloth, £5.

This work consists of a series of comprehensive reference tables of all the dyes of known constitution which have received commercial names. The information is designed to meet the requirements of the colour manufacturer, the users of colours and the student of colour chemistry. The first of the monthly parts, now under notice, contains three parts of the "Section A, Synthetic Organic Dyestuffs," viz. (1) Nitroso Colouring Matters (Quinone Oximes), (2) Nitro Colouring Matters, and (3) Mono-azo Colouring Matters, and deals with 107 dyes. The first column contains the index number of the dye and in brackets the corresponding number from the 1914 edition of *Farbstofftabellen* by G. Schultz. The second column contains the commercial names of the dye and the abbreviated name of the manufacturer. The third column contains the scientific name, components and formula, the fourth column the method of preparation, the fifth

column the name of the discoverer and reference to literature, while the sixth column contains a description of the colouring matter, its properties, fastness and mode of application. A further column is provided for notes. Since the earlier parts of the Index will be published before the whole of the information for the entire volume has been collected, a temporary introduction, scale of fastness and key to abbreviations have been included in Part I, and these will be subjected to revision for publication in the final issue.

Civil Engineering Geology. By Cyril S. Fox, B.Sc., M.I.M.E., F.G.S., Geological Survey of India. Pp. xvi + 144, 8vo, 10 × 6½. (London: Crosby Lockwood & Son, 1923.) Price 18*s*.

This work is divided into three parts. Part I, on water-supply and irrigation, has separate chapters on rainfall, rivers and canals, reservoirs, infiltration channels and wells, and artesian conditions. Part II, on field operations, treats of retaining walls, tunnels and shafts, stability of hill-sides, quarrying and mining, and building sites. Part III, on building materials, deals with the occurrence, principal groups, minerals and physical properties of rocks, and choice of materials. The work is illustrated with 51 figures, 14 photographs and 6 photomicrographs. Most of the photographs were taken in India, and are interesting examples of geological structure. The text is clearly written, without being overburdened with detail, and the illustrations are excellent. The work is by no means exhaustive, and may be regarded as an admirable introduction to civil engineering geology rather than a complete textbook on the subject.

Elements of Optical Mineralogy: An Introduction to Microscopic Petrography. By N. H. Winchell and A. N. Winchell. Second edition, entirely rewritten and much enlarged by A. N. Winchell. Part I, Principles and Methods. Pp. xv + 216, 8vo, 9¼ × 6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1922.) Price 17*s*. 6*d*.

The object of this work is to present a reasonably complete account of the principles and methods of optical mineralogy, together with descriptions and determinative tables of all minerals whose optical character can be studied microscopically. It is hoped to produce two further parts in the course of a year or two.

The first four chapters are purely introductory "to

make the later part more easily understood," and deal very concisely with elementary conceptions, crystallography, and the physical and chemical characters of minerals. It would seem, however, that the vast amount of information crowded into 40 pages, admirably expressed though it is, is so condensed that much of it would be quite incomprehensible to a beginner. The remainder of the work has been done very thoroughly, commencing from first principles.

After a general account of the properties of isotropic substances, there is a good account of the petrographic microscope, a description of the preparation of material for examination both as a thin section and as a fine powder, and a detailed account of the methods by which the refractive index may be accurately measured microscopically. One chapter deals with the Nicol prism and its effect on light. The optical characteristics of isotropic, uniaxial and biaxial minerals are discussed in turn.

A useful feature of the volume is the inclusion in most chapters of a course of laboratory work for the student. The book is clearly written and well illustrated.

A Handbook of the Petroleum Industry. By David T. Day, Ph.D. In two volumes: Vol. I, Pp. x + 964; Vol. II, Pp. vi + 1006, 8vo, $9\frac{1}{4} \times 6\frac{1}{4}$. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1922.) Price 75*s*.

This work, written in collaboration with several contributors and associate editors, is by far the most complete American work on the petroleum industry yet published. The sections, each one of which is by a specialist, are referred to below in the order in which they occur in the volumes. That on the occurrence of petroleum is by Frederick G. Clapp. The portion relating to structure is particularly good, and although, naturally, most of the examples are taken from the oil-fields of the United States, some from the Rumanian, Russian, Indian and Mexican fields have been included. The portion relating to geographical occurrence is somewhat short, but the descriptions of the South American oil-fields, especially those of Peru, Argentina, Colombia, Venezuela and Trinidad are of value. In the discussion of field methods in petroleum geology, by Frederick H. Lahee, the various ways of checking barometric readings are well described. Oil-field development and petroleum production are gone into very fully by Louis C. Sands, the text being chiefly confined to the cable and rotary systems, although the dual and combination systems are briefly referred to. The portion on fishing

and fishing tools is excellent, and eminently practical. It is stated that blow-out preventers are used for heavy gas pressures, but they are also sometimes used to control high pressures of fine sand and oil, as in the Trinidad oil-field. Statistics of petroleum and natural gas have been compiled by Anne B. Coons. The section on the transportation of petroleum products, by Forrest M. Towl, is confined to American practice. The method of laying pipe-lines and the tools used are clearly described and illustrated, and there is a sub-section on the transportation of natural gas by T. R. Weymouth and F. M. Towl. David T. Day, the editor, describes the characteristics of petroleum, a full list of the hydrocarbons in petroleum being given, and the authorities quoted. Petroleum testing methods are fully dealt with by T. G. Delbridge. Then follow sections on natural-gas gasoline, by H. C. Cooper; asphalt, by R. G. Smith, and oil shale by David Eliot Day. The section on refining by A. D. Smith goes fully into the construction of stills, condensers, towers, and steel and concrete storage tanks. The processes employed in the separation of the various constituents of crude petroleum are described in detail, together with special refining processes, such as the Simplex, the Sharples, the Edeleance and the petrol-alcohol. Cracking processes are dealt with by Roland B. Day, while W. H. Best treats of the use of fuel oils. Sections on internal combustion petroleum engines by A. H. Goldingham; on lubrication by John D. Gill, and on pipe standards and the use of pipes by F. N. Speller are followed by general tables and a glossary. It seems a pity that the glossary was not strictly confined to terms used in the petroleum industry. Descriptions of "ore," "ore in sight," "miner's inch" and others might well have been left out, and room made for a few more petroleum terms which appear in the text.

Cements, Limes and Plasters: Their materials, manufacture and properties. By Edwin C. Eckel. Second Edition, revised and partly rewritten. Pp. xxxi + 655, 8vo, 9¼ × 6¼. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1922.) Price 35*s*. 6*d*.

The general scheme of this work is the same as that of the first edition, the subject matter being divided into seven parts.

A good account is given of the distribution of gypsum in the United States, Canada and Newfoundland, and the details of manufacture, properties and tests of its various products are described together with statistical information regarding the utilisation of the mineral in the United States.

The various types of lime kilns, the properties of limes and methods of utilisation are discussed, and useful data are given concerning the cost of manufacture. Lime-sand bricks, their manufacture, properties and testing, are treated at some length.

The source, manufacture and use of magnesia, magnesia bricks and oxychloride cements are described. In discussing the hydraulic limes the author introduces his "Cementation Index" for expressing quantitatively the relation between the chemical composition of a raw cement material and its hydraulic value after burning. As a method of classification and indication of the hydraulic possibilities of raw materials, it is undoubtedly useful, but its limitations should always be kept in mind.

Many analyses of "natural cement" rock which appeared in the first edition have been deleted, but the effect of composition on the degree of burning, the types of kiln used, fuel consumption, and other details are retained in their entirety.

The production of Portland cement is dealt with in an exhaustive manner; typical analyses of each raw material are given and considerable attention is devoted to methods and costs of excavating. The equipment of many plants for both "dry" and "wet" processes is described, and the conditions most favourable for their employment are discussed. All the ordinary types of stationary kilns are considered, but no mention is made of the recent forms of continuous stationary kilns in which rotary grates are used. The economics of the rotary kiln naturally receive much attention, and the important matter of heat consumption and utilisation is fully treated.

The requisite composition and properties of fuels—coal, oil, natural gas and producer gas—and their treatments are described, and a chapter is devoted to clinker cooling, grinding and storage and the use of gypsum as a retarder. Methods of testing are only touched on incidentally.

The utilisation of blast furnace slags in the manufacture of slag cements and bricks comprises the greater portion of the concluding part of the book.

The volume is well written, profusely illustrated, and the comprehensive references to original sources of information help to make it one of the best works of reference on the subject.

CLAY PRODUCTS CYCLOPEDIA, 1922. Containing Important Information for Every Executive from President to Foreman of Every Branch of the Clay Products Indus-

try, including both Pottery and Heavy Clay Products. Pp. 252, 4to, 12 × 9. (Chicago: Industrial Publications, Inc., 1922.) Price $3.

This book consists of three sections: (1) a "definition" section with 709 items, (2) a "statistical" section, and (3) trade advertisements.

The definition section is arranged alphabetically as an encyclopædia, and in addition is provided with an index in which various connected items are classified under general headings. This index is useful in cases where it is desired to find the whole of the information available in the book on a particular branch of the ceramic industry. The items generally are brief, though certain subjects, e.g. kilns, are treated at some length. Certain omissions are noticed, chiefly in connection with recent developments. Molecular formulæ and percentage compositions are both employed in the work, but no explanation is given of the method of compounding a glaze or body from a molecular formula.

The second or "statistical" section contains not only important statistics relating to clay products, but also gives detailed information on a large number of the subjects included in the first section, cross reference being facilitated by the use of the same headings and numbers in each section. Certain unofficial methods of clay testing are described, and, in addition to a quantity of engineering information, a number of methods and specifications of the American Society for Testing Materials are given.

The book contains a good deal of information available for ready reference, and should certainly be useful to those concerned with the clay products industries.

Mechanical Testing. By R. G. Batson, A.M.Inst.C.E., A.M.I.M.E., and J. H. Hyde, A.M.Inst.C.E., M.I.A.E., A.M.I.M.E. Volume II, Testing of Prime Movers, Machines, Structures and Engineering Apparatus. (The Directly Useful [D.U.] Technical Series.) Pp. xi + 446, 8vo, 8½ × 5½. (London: Chapman & Hall, Ltd., 1922.) Price 25*s*.

The first volume of this treatise was concerned with the mechanical testing of materials of construction, and was reviewed in this Bulletin (1922, **20**, 284); the second and final volume deals with the methods and apparatus employed for the testing of prime movers, machines and structures. It is an interesting and instructive work, and should be of much practical utility.

The student will find adequate references enabling him

to obtain further and more complete information on any particular subject, where, owing to the wide ground covered by the book, only broad outlines have been attempted by the authors.

After an explanation of the theory of dynamometry, the various types of absorption and transmission dynamometers are reviewed, the best-known machines being described in each case. Chapters follow devoted to the methods and machinery used in testing springs, bearings, gears and other important parts of prime movers and machines. Those readers who are concerned with constructional engineering will appreciate the information on testing concrete, reinforced concrete beams, columns and struts, and the chapter dealing with the measurement of movement of masonic structures due to vibration and subsidence and the stresses and deflections produced in structures under dead load, impact, etc.

Descriptions are given of the manner in which cutting tools are tested, and of the apparatus used for applying and measuring hydraulic pressure ; tests on aircraft models follow and the volume closes with a chapter on miscellaneous tests and testing apparatus.

The subject matter of the book is treated in a thorough manner and the illustrations and figures are all of good standard.

PHILIPS' COMMERCIAL MAP OF CHINA. Edited by Sir Alexander Hosie, M.A., LL.D., F.R.G.S. 62 × 45 inches. (London: George Philip & Son, Ltd., 1922.) Price, mounted on cloth and varnished, with rollers, 50*s.* ; mounted on cloth, folded in case, 55*s.*

This useful publication consists of a well-printed map of China, on the scale of 48 miles to the inch, and a concise and informative Handbook by Sir Alexander Hosie, entitled " China—Geographical, Commercial, Industrial." The Map is printed in black and five colours ; it is not burdened with unnecessary details, but it contains, in addition to the usual topographical features, a mass of valuable information regarding the animal, vegetable and mineral products and the principal manufactures of the country. In order to indicate the districts in which the principal products occur and the localities in which the chief manufacturing industries are carried on, no less than ninety-eight distinctive symbols are used. The map also shows railways, navigable rivers, canals, steamer routes, submarine cables, telegraph lines, wireless stations and caravan routes ; and an index to it is provided at the end of the Handbook.

The contents of the Handbook itself can best be indicated by quoting the following titles of sections: The Chinese Peoples, Currencies, Communications, Foreign Relations, Industrial Development, Trade. This last-named section includes a large amount of information regarding natural products and manufactures. Not much can be quoted here from the particulars given in the Handbook, but it may be mentioned that there are now 7,000 miles of railway in China and over 49,000 miles of land telegraph lines; that in 1919 a quantity of 2½ million tons of soy beans and soy bean products was exported, the value of this item being exceeded only by that of the exports of silk; that in 1920 the value of the wheat and flour exported was nine times as much as in 1913; and that as regards natural resources it is believed that China has a reserve of coal sufficient to supply the whole world for a thousand years.

The statistics which appear in the Handbook include a table of population, from which it is noted that whilst the "Foreign Customs Estimate" of the population of China is about 441 million (exclusive of Sinkiang) the Chinese census of 1910 gave a figure (including Sinkiang) of only 335 to 336 million. Both these estimates include Manchuria, which according to the Chinese census had in 1910 a population of about 15 million. In addition to the figures mentioned, Mongolia and Tibet account for a further 5 million people.

The Map and Handbook together form an admirable production, which should be extremely useful to all concerned with China and its development, whether as traders, politicians, or teachers of commercial geography; whilst the name of Sir A. Hosie is a guarantee both of the reliability of the information furnished and the care which has been given to the publication as a whole.

BOOKS RECEIVED

MALAYA : THE STRAITS SETTLEMENTS AND FEDERATED AND UNFEDERATED MALAY STATES. Edited by R. O. Winstedt, M.A., D.Litt. (Oxon.). Pp. xi + 283, 9 × 5¾. (London : Constable & Co., Ltd., 1923.) Price 12*s.*

BURMA. By Sir Herbert Thirkell White, K.C.I.E. Pp. x + 226, 8 × 5½. (Cambridge : The University Press, 1923.) Price 8*s.* 6*d.*

PATROLLING IN PAPUA. By W. R. Humphries, A.R.M., with an Introduction by J. H. P. Murray, Lieutenant-Governor and Chief Judicial Officer of Papua. Pp. 287, 9 × 5¾. (London : T. Fisher Unwin, Ltd., 1923.) Price 21*s.*

BERMUDA : PAST AND PRESENT. By Walter Brownell Hayward. Pp. xii + 237, 7½ × 5. (London : Stanley Paul & Co.) Price 8*s.* 6*d.*

THE POCKET GUIDE TO THE WEST INDIES. By Algernon Aspinall, C.M.G. New and Revised Edition. Pp. x + 479, 7 × 4½. (London : Sifton Praed & Co., Ltd., 1923.) Price 10s.

THE SOUTH AND EAST AFRICAN YEAR BOOK AND GUIDE. Edited annually by A. Samler Brown, F.R.M.S., and G. Gordon Brown, F.R.G.S., for the Union-Castle Mail Steamship Company, Limited. 1923 Edition. Pp. l + 916, 7½ × 5. (London : Sampson Low, Marston & Co., Ltd.) Price 5*s.*

THE BEGINNINGS OF AGRICULTURE IN AMERICA. By Lyman Carrier, B.S., M.Agr. Pp. xvii + 323, 9½ × 6½. (London : McGraw-Hill Publishing Co., Ltd., 1923.) Price 15*s.*

THE COCONUT PALM : THE SCIENCE AND PRACTICE OF COCONUT CULTIVATION. By H. C. Sampson, C.I.E., B.Sc. Pp. xiv + 262, 10 × 6½. (London : John Bale, Sons and Danielsson, Ltd., 1923.) Price 31*s.* 6*d.*

DER ÖLBAUM IN KLEINASIEN. By Dr. E. Fickendey. Pp. vii + 112, 10 × 7. (Leipzig : K. F. Koehler, 1922.)

INDIAN TEA: ITS CULTURE AND MANUFACTURE. By Claud Bald. Fourth Edition. Pp. x + 397, 8½ × 5½. (Calcutta: Thacker, Spink & Co., 1922.) Price Rs.12.

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REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

The following summaries have been prepared from a selection of the Reports made by the Director of the Imperial Institute to the Dominion, Colonial and Indian Governments.

THE SODA DEPOSITS OF LAKE MAGADI IN KENYA

AN adequate and cheap supply of sodium carbonate is of great industrial importance. The greater part of the world's supply is obtained by the chemical treatment of common salt, but in certain parts of the world there are natural deposits of sodium carbonate and bicarbonate which are worked. One of the most notable of these, both as regards the extent of the deposit and the purity of the material, is that of Lake Magadi in Kenya Colony.

In March 1908 the Imperial Institute was consulted by the Colonial Office with reference to certain proposals then under consideration for the industrial development of the soda deposits of Lake Magadi, which lies in about the centre of the Rift Valley and not far from the border of Tanganyika Territory. The information available at that time regarding the soda deposits of this lake was insufficient to show: (1) whether the crust of soda on the surface of the lake was of uniform composition throughout, (2) the nature and extent of the underlying deposits on which the renewal of the supply of soda depended, and (3) whether there was any accumulation of residual impurities in the water present in the crust. As these matters were of considerable importance in connection with the valuation of the deposit, the Imperial Institute suggested to the Colonial Office that Mr. J. S. Coates, who had then completed his term of service as

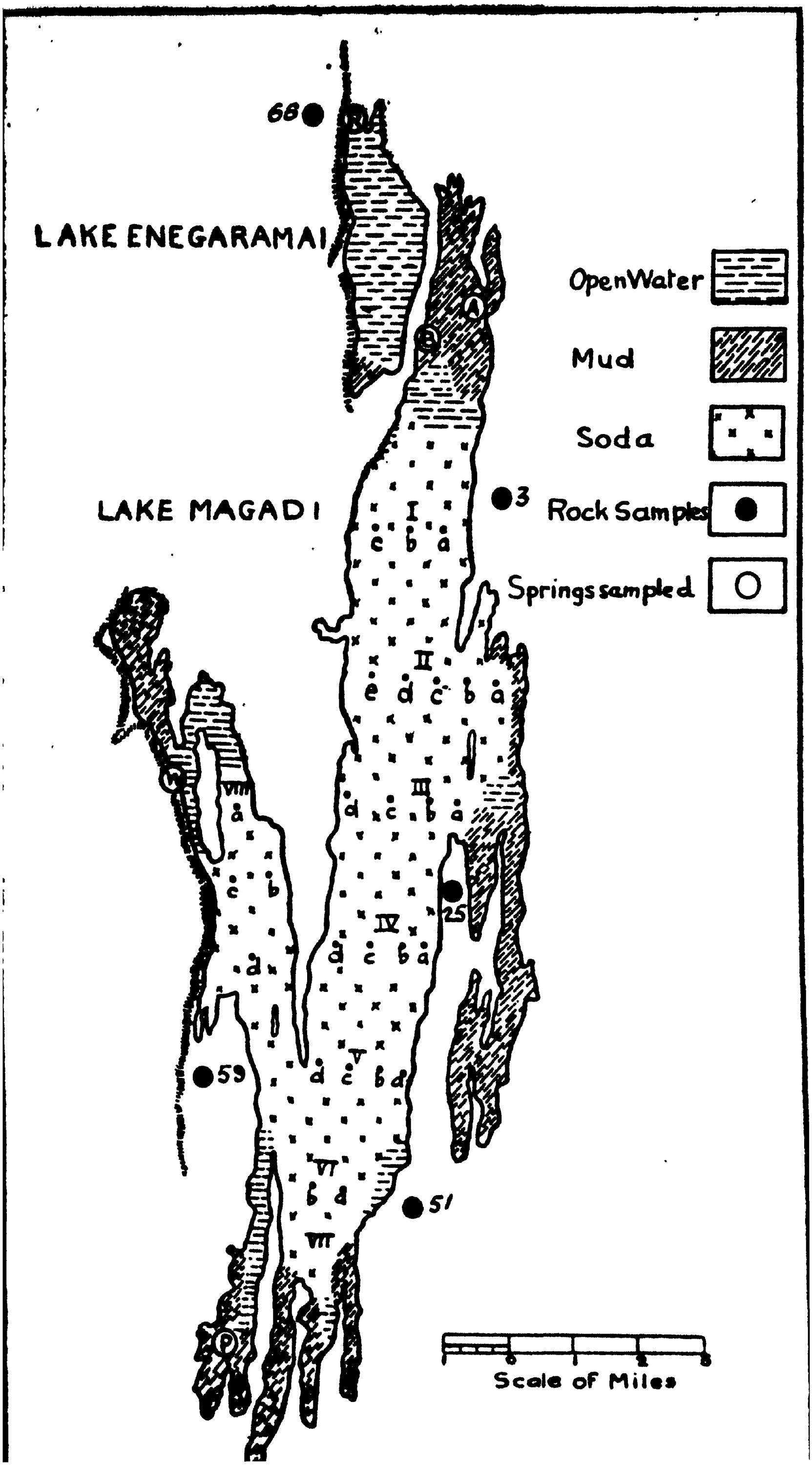
Geologist accompanying the Anglo-Congolese Boundary Commission, should visit and examine Lake Magadi and the geological features in its immediate vicinity, and accordingly he was instructed to undertake this investigation.

Mr. Coates made a detailed examination of Lake Magadi, and the present article includes a summary of his report, the composition of the samples collected as ascertained by analysis at the Imperial Institute, and considerations as to the probable origin of the alkali and the prospects of its continued production.

The main part of Lake Magadi is at an altitude of about 2,000 ft. above sea-level and occupies a narrow fault-trough in the Rift Valley which is elongated in a N.N.E.–S.S.W. direction. The length of the lake is 17 miles and its average breadth 1¾ miles. As there are no permanent streams of fresh water in the neighbourhood no fresh water enters the lake, which has no outlet. The nearest stream is the Guaso Nyiro, about 6 miles distant from the S.E. end of the lake. The average temperature of the district is high, but the locality appears to be healthy and free from malaria.

The soda deposit covers the whole width of the trough for a length of 12 miles in the middle portion of the lake bed, as is shown in the sketch map on page 433. Near the shore the soda forms only a thin soft layer on the mud of the lake bottom, and is covered by a layer of liquor. At a distance of 200 yds. from the shore the soda crust has already a thickness of more than 6 ft.

Owing to the limitations of the tools available Mr. Coates was only able to drill to a depth of 6 ft., but he was of opinion that no liquid layer would be found underlying the soda crust. The crust was pierced by drilling in two places near the edge of the deposit, and in neither case was any liquid substratum found, the soda lying in immediate contact with the mud of the lake bottom. The interstices and cavities, however, of the crystalline matter were filled with liquid. The crust was not uniform, consisting of several layers differing somewhat in structure and separated by cavities filled either with alkaline liquor or with a mixture of loose crystals and mud.


LAKE ENEGARAMAI
LAKE MAGADI
Open Water
Mud
Soda
Rock Samples
Springs sampled
68
3
25
59
51
I
II
III
IV
V
VI
VII
VIII
Scale of Miles

A large number of hot springs arise along the margin of the lake, and discharge into it. The water of most of these springs is alkaline, and in some cases attains a temperature of about 100° F. Their outflows vary considerably in quantity, ranging from a few gallons to more than a thousand gallons per minute. One of the springs (marked P in sketch map) at the south end of the lake had an outflow of 2,550 gallons per minute. The surface of the lake in the vicinity of each spring consists of open water.

At the N.W. extremity of Lake Magadi, and separated from it by a narrow strip of rock is a smaller lake, Lake Enegaramai, 5 square miles in area. On the east side this lake is very shallow, and on the west is inaccessible, as it is bounded by a nearly perpendicular scarp 500 to 800 ft. high. The water of the lake is open throughout and carries no soda crust, although it is strongly alkaline, and resembles in composition the water at the extremities of Lake Magadi. The lake is fed at its northern end by numerous hot springs, the water of which in some cases has a temperature approaching the boiling point. The discharge from the chief group of Enegaramai springs was estimated at 3,000 gallons per minute, and the outflow of all the springs at over 4,000 gallons per minute.

The density of the soda crust on Lake Magadi was estimated at about 76·4 lb. per cubic foot. Assuming a depth of 5 ft. of crust over an area of 22½ square miles—and this may be taken as a proved minimum—it follows that the amount of crude soda available is not less than 107,000,000 tons. Lake Magadi is therefore the largest known natural source of sodium carbonate.

Although it is shown by the analyses that the liquid from which this crystalline crust has separated contains in solution other salts, notably sodium chloride and sodium sulphate, the conditions are such that the separated crystals are practically pure trona, a mixture of carbonate and bicarbonate of soda or sesquicarbonate of soda ($Na_2CO_3.NaHCO_3.2H_2O$) which only needs to be freed by draining or washing from the adherent liquid to become a very pure material.

Composition of the Soda, the Water from Hot Springs, and the Rocks of Lake Magadi

The samples forwarded by Mr. Coates to the Imperial Institute are described below under eight headings. The numerals and letters used to distinguish the samples are shown on the sketch map so that the positions at which the samples were collected are roughly indicated.

Group 1.—Samples of crust down to a depth of 3 ft. 6 in. These samples were marked Ia, Ib, Ic; IIa, IIb, IIc, IId, IIe; and so on.

Group 2.—Samples of crust taken from some of the positions at which the samples forming Group 1 were obtained, but at a greater depth, namely, from 3 ft. 6 in. to 5 ft. 6 in. These samples were marked Ia2, Ib2, IIa2, etc.; thus Ia2 represents the material obtained below Ia, IIIc2 that below IIIc, and so on.

Group 3.—Samples of crust taken from holes in rows III, IV and V as shown on the sketch map but at various depths. These samples were marked S.G.IIIa, S.G.IIIb, and so on, the small letters indicating the depth at which the sample was taken, thus a = upper layer, b = second layer, c = third layer, and so on.

Group 4.—Samples of the alkaline liquor which was entangled with the crust. These were marked IIIa, IIIb, IIIc, IIId, and so on.

Group 5.—Samples of water from alkaline springs discharging into Lake Magadi.

Group 6.—Samples of water from alkaline springs discharging into Lake Enegaramai.

Group 7.—Sample of water from Lake Enegaramai. This was marked 7.

Group 8.—Rock specimens collected in the vicinity of Lake Magadi.

The total number of samples collected was 164. These were submitted to a preliminary examination and a certain number considered to be representative were selected for detailed investigation. The results of this work are as follows:

Group 1.—Samples of the lake crust taken from the surface down to a depth of 3 ft. 6 in.

Five of these were selected for analysis. All the samples of this group consisted of broken masses of elongated and interlacing crystals of trona. They were greyish in appearance and all fairly clean except No. VIb which contained a considerable amount of earthy impurity. The selected samples gave the following results on analysis :

		Ib.	IIIc.	IVb.	VIb.	VIIIa.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Sodium carbonate	Na_2CO_3	45·02	44·58	44·00	42·67	47·25
Sodium bicarbonate	$NaHCO_3$	34·64	35·88	35·30	29·03	29·80
Sodium chloride	NaCl	1·62	1·53	2·84	3·72	2·09
Water [1]	H_2O	16·32	16·33	16·21	15·70	17·56
Insoluble matter		1·82	1·82	1·30	7·65	2·33

[1] *In these and the succeeding analyses of samples of the lake crust the "water" includes moisture and water of crystallisation.*

Group 2.—Samples of crust from a depth of 3 ft. 6 in. to a depth of 5 ft. 6 in.

Four of these were analysed. Like the samples of Group 1 they consisted of masses of interlacing trona crystals, but on the whole were cleaner. They gave the following results on analysis :

		Iba.	IIIca.	IVba.	VIIIaa.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Sodium carbonate	Na_2CO_3	43·86	46·09	44·78	45·23
Sodium bicarbonate	$NaHCO_3$	38·20	34·29	34·33	34·34
Sodium chloride	NaCl	0·80	1·78	3·86	2·36
Water [1]	H_2O	16·62	16·82	16·38	17·02
Insoluble matter		1·05	0·68	1·40	1·07

[1] *See above.*

Group 3.—Samples of crust collected at various depths to ascertain whether the composition of the crust varied with depth.

These resembled the samples of Groups 1 and 2. Those marked S.G.Va and S.G.Vc (*see* table below) were very clean, the former having a pinkish colour. The other two were darker in colour owing to the presence of larger amounts of earthy impurity.

Four of these, collected from one bore-hole, were examined with the following results :

		S.G.Va. Upper Layer. Per cent.	S.G.Vb. Second Layer. Per cent.	S.G.Vc. Third Layer. Per cent.	S.G.Vd. Fourth Layer. Per cent.
Sodium carbonate	Na_2CO_3	48·20	43·61	46·03	49·40
Sodium bicarbonate	$NaHCO_3$	32·08	36·35	36·29	28·26
Sodium chloride	$NaCl$	2·89	3·15	0·97	2·19
Water[1]	H_2O	16·10	15·99	17·12	18·35
Insoluble matter		0·45	0·81	0·19	1·11

[1] *See footnote on p.* 436.

Reference to the sketch map will show that the samples in Groups 1 and 2 selected for analysis were taken at various points along the lake. The analytical results show very little difference in the composition of the crust at the various depths either for the topmost layer of 3 ft. 6 in. or for the lower layer between 3 ft. 6 in. and 5 ft. 6 in. Similarly the set of four samples of Group 3, taken at various depths in one bore-hole in row No. V, show that there is very little variation in the composition of the crust with the depth.

The whole of these analytical results taken together indicate that the crust is of fairly uniform composition throughout.

Group 4.—*Alkaline Liquors from Lake Magadi.*

The samples were taken from holes bored in the crust after a period of fifteen days of calm weather and represent the residual liquor, entangled in the crust, which had drained into the holes. They consisted of saturated liquor and were of dark-brown colour. As received, all had deposited a considerable quantity of crystalline matter, but this passed into solution again on warming the liquor to 40° C. The following are results of analyses made on liquors so treated, amounts being given in grams per 100 c.c.:

		IIIa.	IIIc.	IVb.	IVc.
Total solid matter		38·47	43·45	52·49	45·31
Including:					
Sodium carbonate	Na_2CO_3	19·37	24·59	28·27	23·11
Sodium chloride	$NaCl$	15·99	16·94	21·30	19·04
Sodium bicarbonate	$NaHCO_3$	1·22	0·31	0·43	0·88
Sodium sulphate	Na_2SO_4	0·26	0·09	0·48	0·47
Potassium chloride	KCl	0·17	0·09	0·32	0·38
Suspended matter		0·39	0·04	0·17	0·15

These results show that the residual liquor is almost as rich in sodium chloride as in carbonate, and indicate that the effective draining away of this liquor from the soda crust is necessary to secure a soda product of a high degree of purity.

In view of the richness of these liquors in sodium chloride it was considered of interest to examine the crystalline matter they deposited when cooled below 40° C. For this purpose the deposit from sample Vc was selected. It was found to consist essentially not of trona (sodium sesquicarbonate) like the soda crust, but of heptahydrated sodium carbonate (Na_2CO_3, $7H_2O$). The top layers of the crystalline matter, i.e. the portion still in contact with the liquor, contained 1·85 per cent. of sodium chloride. The residual liquor contained 23 per cent. of sodium chloride, and as the crystals were not washed before they were analysed the sodium chloride they contained was due to the inclusion of small quantities of the mother liquor. It is clear from this result that the residual liquor of Lake Magadi, although rich in sodium chloride, has no tendency to deposit this salt at present.

Group 5.—Waters from springs discharging into Lake Magadi.

These were all clear colourless liquids; the four selected for analysis were as follows:

(A) Taken from a stream flowing southwards from a pool which is fed by numerous small jets of hot liquor arising from fissures and joints in the lavas at the N.E. arm of Lake Magadi.

(B) Obtained from a stream on the west side of the N.W. arm of the lake.

(P) Taken from the group of springs which arise in the most western part of the southern arm of the lake. The water rises from basins worn in the hard clay of the lake bottom.

(W) Taken from a group of small jets rising from cracks in the clay at the foot of the high scarp which bounds the western arm of the lake.

The results of analysis are given in the following table in which amounts are given in grams per 100 c.c.:

		A.	B.	P.	W.
Total solid matter		4·630	2·150	3·663	2·770
Including:					
Sodium carbonate	Na_2CO_3	1·610	0·933	1·227	0·482
Sodium bicarbonate	$NaHCO_3$	1·680	0·527	1·283	1·474
Sodium chloride	NaCl	1·295	0·646	1·035	0·744
Sodium sulphate	Na_2SO_4	0·038	0·005	0·038	0·038
Potassium chloride	KCl	0·039	0·011	0·008	0·0087
Suspended matter		—	nil	nil	0·0006
Discharge from spring, gallons per minute		1,150	450	2,250	Figures not avail-able.
Discharge of sodium carbonate and bicarbonate in lb. per minute		378	179	637	

These results indicate that whilst the chief saline constituents of all these springs are the same, there is considerable variation in the quantity of saline matter in the spring waters and also in the relative amounts of the constituents. It is noticeable that the amount of sodium chloride present in these waters is relatively large in comparison with the amounts of sodium carbonate and bicarbonate, which together form the principal part of the crust. The fact that the crust eventually derived from these spring waters is poor in sodium chloride depends upon the relatively great solubility of the chloride.

Group 6.—Waters from springs discharging into Lake Enegaramai.

These were clear, colourless liquids. One (sample R) which issued from a bed of breccia at the foot of a high scarp at the N.W. corner of the lake was selected for analysis, and gave the following results in grams per 100 c.c.:

Total solid matter		3·503
Including:		
Sodium carbonate	Na_2CO_3	0·654
Sodium bicarbonate	$NaHCO_3$	1·856
Sodium chloride	NaCl	0·904
Sodium sulphate	Na_2SO_4	0·030
Potassium chloride	KCl	0·014
Suspended matter		trace
Discharge from spring in gallons per minute		3,000
Discharge from spring of sodium carbonate and bicarbonate in lb. per minute		753

This spring water resembles in composition those included in Group 5, which are discharged into Lake Magadi.

Group 7.—Water from Lake Enegaramai.

This was clear and colourless. It gave the following results on analysis in grams per 100 c.c.:

Total solid matter		5·440
Including:		
Sodium carbonate	Na_2CO_3	1·615
Sodium bicarbonate	$NaHCO_3$	2·193
Sodium chloride	$NaCl$	1·490
Sodium sulphate	Na_2SO_4	0·036
Potassium chloride	KCl	0·052
Suspended matter		0·009

The results show that this water, though comparatively weak in saline matter, contains over 1½ times as much salts as the spring water (R) feeding the lake.

Group 8.—Rocks from the vicinity of Lake Magadi.

Of the rocks collected in the vicinity of the lake, six were selected for chemical analysis, as follows:

No. 3 from N.E. side of Lake Magadi.

No. 25 from tongue of rock projecting into the lake about the middle of the east side.

No. 28 from the Lendurut Hills, a few miles to the south of Lake Magadi.

No. 51 from the S.E. side of Lake Magadi.

No. 59 from the S.W. side of Lake Magadi.

No. 66 from the N.E. side of Lake Enegaramai.

The analyses gave the following results:

		3. *Per cent.*	25. *Per cent.*	28. *Per cent.*	51. *Per cent.*	59. *Per cent.*	66. *Per cent.*
Silica	SiO_2	59·41	59·38	53·79	61·24	60·25	63·81
Alumina	Al_2O_3	12·03	10·84	16·45	13·53	10·87	12·76
Ferric oxide	Fe_2O_3	4·53	3·92	4·77	4·52	5·08	4·74
Ferrous oxide	FeO	3·93	4·28	2·71	3·36	3·50	1·65
Manganous oxide	MnO	0·65	0·35	0·54	0·34	0·83	0·31
Magnesia	MgO	0·63	0·89	1·92	1·06	0·83	0·57
Lime	CaO	1·39	3·31	5·64	1·98	2·73	0·40
Soda	Na_2O	6·37	5·60	4·32	4·95	6·29	5·67
Potash	K_2O	4·36	5·01	2·71	3·86	4·77	5·12
Titanium dioxide	TiO_2	0·81	0·81	1·77	0·99	0·88	0·69
Phosphoric anhydride	P_2O_5	1·06	1·00	0·86	0·99	1·62	1·58
Carbon dioxide	CO_2	trace	1·30	absent	0·35	1·06	0·18
Sulphuric anhydride	SO_3	0·27	0·04	0·10	0·09	0·08	0·24
Chlorine	Cl	0·05	0·007	0·04	0·02	0·06	trace
Water	H_2O	4·05	3·14	4·02	2·50	1·25	2·67

No. 3 is a soda-pitchstone; Nos. 25, 51, 59 and 66 are soda-trachytes, and No. 28 is a pyroxene-andesite. No nepheline or any other felspathoid was observed in these particular specimens, the alkali being present in them chiefly in the form of felspar.

The Origin of the Soda Deposits

The rocks of the Rift Valley area, in which Lake Magadi is situated, are characterised by an abundant development of soda minerals, including nepheline, which is a readily decomposed silicate of sodium and aluminium. Although this mineral is apparently scarce in the surface rocks immediately surrounding the lake, as indicated by the results of examination of specimens at the Imperial Institute, its abundance in the rocks which occupy adjacent districts of the Rift Valley is of significance in connection with the origin of the Magadi soda deposits.

Rainwater with carbonic acid in solution is capable of decomposing nepheline and other felspathoids quite readily, leaching out soda and forming sodium carbonate. This surface water with sodium carbonate in solution seeps into the rocks and penetrates along cracks and fissures to a considerable depth.

In a region such as that of the Rift Valley, where the volcanic rocks are of comparatively recent formation, and where the latest phases of volcanic activity are still operative, much carbon dioxide, together with some hydrochloric and sulphuric acids, is emitted from the earth's crust. These are absorbed by seepage waters, intensifying the solvent action of the latter upon the readily decomposable sodium minerals. Ultimately these waters come into contact with the yet uncooled lavas, and are thrown back to the surface in the form of hot spring waters, mixed to some extent no doubt with primary water which has been exuded from the hot rocks below.

The composition of these spring waters indicates that fresh supplies of sodium carbonate are being added constantly to the lake, and there appears to be no reason why these supplies should not continue for an indefinite period.

Utilisation of the Deposits

The technical side of the utilisation of the Magadi soda, at least in principle, is a very simple matter, since the crust after removal merely requires draining, washing and roasting to convert it into soda ash (dry sodium carbonate) of a high degree of purity, which can be exported as such, or converted in Kenya into other sodium compounds required in commerce, such as caustic soda and soda crystals.

The following table gives (1) the average composition of Lake Magadi soda as computed from the thirteen analyses quoted in the early portion of this report, (2) the probable average composition of soda ash made from Magadi soda, (3) the average composition of commercial soda ash made (*a*) by the Leblanc process and (*b*) by the ammonia-soda process.

		Magadi Soda Crust	Magadi Soda Ash	Leblanc Soda Ash.	English Ammonia-soda Ash.	Solvay Soda Ash.
		Per cent	*Per cent*	*Per cent*	*Per cent.*	*Per cent*
Sodium bicarbonate	$NaHCO_3$	33·84	—	—	—	—
Sodium carbonate	Na_2CO_3	45·44	94·36	98·20	98·72	99·44
Sodium chloride	NaCl	2·30	3·24	0·10	0·54	0·21
Sodium sulphate	Na_2SO_4	—	—	0·60	0·20	—
Insoluble matter	. .	1·66	2·40	0·11	0·09	—
Water		16·73	—	0·67	0·32	0·31

From these results it appears that "soda ash" made from Lake Magadi soda might be slightly inferior to soda ash of commerce in containing a larger quantity of sodium chloride, but in this connection it must be remembered that in collecting the samples of soda no special precautions were taken to remove the adherent and entangled mother liquors which are rich in sodium chloride, as shown by the analyses recorded on p. 437. In actual practice arrangement would be made for the removal of this entangled mother liquor.

Reference has been made already to another point of importance in connection with the utilisation of this soda deposit, viz.: the accumulation of sodium chloride and other impurities in the lake water. It is clear from the analyses made that there is at present no indication that sodium chloride has separated out with the soda,

the small amounts of sodium chloride found in the crust being due to small quantities of lake water entangled in it. Further, the supplies of solid soda already available are so large that no practical difficulty from the deposition of sodium chloride is likely to occur for a very long time, and this conclusion is confirmed by the fact already noted that the lake liquors when cooled continue to deposit sodium carbonate. It seems likely, however, that since the lake has no outlet the gradual removal of soda and the gradually increasing richness of the residual water in sodium chloride will eventually lead to the deposition of sodium chloride with the sodium carbonate and it is noteworthy in this connection that Mr. Coates states that crystals of rock salt are occasionally found in the under surface of the top layer of the crust where it overlies a liquid stratum.

The exploitation of the Magadi soda deposit was undertaken by the Magadi Soda Co., Ltd., which was formed in 1911, and which undertook the construction of a branch railway line, 93 miles in length, from the deposit to the Uganda Railway, thus connecting it with the port of Kilindini on the coast. The company also undertook the building of a pier and the dredging of approaches at Kilindini. The distance from the lake to the port is about 280 miles, and the route passes over the Kapiti Plains at an altitude of 5,336 ft.

The branch of the Uganda Railway from Ulu to Magadi was completed in August 1915, but the necessary treatment plant had not been conveyed to the deposit. Upon its completion the railway was taken over by the authorities and used for military purposes, and so the work at the lake was brought to a standstill. It was possible, however, in 1917 to make some little progress, and this was continued until early in 1919, when work was again suspended owing to the necessity of certain alterations to the calcining plant at Magadi. Operations were, however, resumed in 1920.

The soda is excavated from the lake by means of a dredger specially designed for the work.

The soda works at Kiu on the shore of Lake Magadi are equipped with two calciners for converting the crude

of medium length. The wood was light greenish-yellow, with greyish-brown pores.

In *transverse section* the wood was light greenish-brown, with numerous pores, seen as pin-holes joined by wavy lines of soft tissue. The rays were almost invisible to the naked eye, but with a glass appeared as fine, closely distributed straight lines; the growth rings were indicated by colour variations. The pith was roughly circular and about ⅜ in. in diameter.

In *radial section* the wood was light greenish-yellow and the pores were seen as long, well-defined, greyish-brown grooves. The rays were visible in some lights as light-coloured flecks. The pith appeared as a brown band bordered by a dark line.

In *tangential section* the wood was similar in colour to the radial section and the pores were seen as numerous well-defined brown grooves. The rays and rings were practically invisible.

Results of Mechanical Tests

The results of the mechanical tests are summarised in the following table:

Summary of Results of the Mechanical Tests on Afara Wood (Terminalia superba)

		Maximum.	Minimum.	Mean.
A.—*Transverse bending test (central loading)*				
Maximum calculated longitudinal shear	*lb./sq in*	367·5	187·5	286·5
Modulus of rupture	,,	10,230	5,225	7,968
Fibre stress at elastic limit	,,	7,850	4,138	6,229
Modulus of elasticity	,,	1,345,000	1,192,000	1,272,000
Elastic resilience	*inch-lb./cu. in*	2·34	0·679	1·70
B.—*Compression test along the grain* (24 *in. length specimen*):				
Crushing strength	*lb./sq. in.*	6,000	5,260	5,620
Fibre strength at elastic limit	,,	5,475	4,125	4,610
Modulus of elasticity	,,	1,233,000	1,213,000	1,223,000
Elastic resilience	*inch-lb./cu. in.*	10·28	5·94	7·46
C.—*Compression test along the grain* (8 *in. length specimen*):				
Crushing strength	*lb./sq. in.*	5,888	5,475	5,738
Fibre strength at elastic limit	,,	4,625	4,500	4,567
Modulus of elasticity	,,	1,285,000	1,100,000	1,198,000
Elastic resilience	*inch-lb /cu. in.*	7·45	6·49	6·87
D.—*Compression test across the grain*:				
Load at elastic limit	*lb.*	4,700	4,200	4,400
Fibre stress at elastic limit	*lb./sq. in.*	1,175	1,050	1,098

E.—*Shearing tests along the grain :*

		Maximum.	Minimum.	Mean.
Radial—				
Maximum load supported	*lb.*	4,710	4,540	4,640
Shearing strength .	*lb./sq. in.*	1,178	1,135	1,160
Tangential—				
Maximum load supported	*lb.*	6,140	6,050	6,100
Shearing strength .	*lb./sq. in.*	1,535	1,513	1,525
Specific gravity		0·515	0·454	0·486
Weight per cubic foot . .	*lb.*	32·2	28·4	30·4
Moisture	*per cent.*	11·37	9·85	10·29

Results of Working Tests

(1) *Sawing.*—The wood cuts readily with and across the grain both by power and hand saws.

(2) *Planing.*—A good surface is easily obtainable with Jack plane and smoothing plane.

(3) *Boring.*—Good clear holes are readily obtained with bradawl, gimlet, centre bit and twist drill, but there is a slight tendency to split.

(4) *Nailing and Screwing.*—Nails and screws can be driven in readily, and they hold well through and along the grain. The wood has, however, a tendency to split.

(5) *Mortising and Dovetailing.*—The wood cuts well in a mortising machine ; fairly strong joints are obtainable.

(6) *Working with Gouge and Chisel.*—The wood can be easily worked and is of medium hardness ; it should be fairly suitable for carving.

(7) *Turning.*—The wood turns fairly well, but the fibres tear slightly. As it is liable to split between centres it would only be suitable for articles with a minimum diameter of 1 in.

(8) *Glueing.*—Strong joints are obtainable.

(9) *Polishing and Varnishing.*—The wood requires filling ; it has a good appearance, is somewhat similar to oak, and has a fairly good figure.

(10) *Shrinkage.*—Original width of plank 16¼ in. ; shrinkage after artificial seasoning, $\frac{1}{16}$ in.

Remarks

The results of the tests show that this Afara wood (*Terminalia superba*) is of medium hardness and strength,

fairly stiff and not unduly brittle. It has fibres of medium length and is slightly cross-grained. This was shown in the transverse bending tests, where in each case the beam failed by cross-grained tension, whilst the manner in which the specimen failed in the shear test also indicated the cross-grained character of the wood.

The wood works well with both machine and hand tools, and, except for a tendency to split, should be useful for general joinery and building purposes.

EKHIMI (PIPTADENIA AFRICANA)

The specimen received for examination consisted of a plank 11 ft. 9 in. long, 18 in. wide and 2 in. thick. The wood had warped considerably, but was sound and free from knots and cracks (except for small " checks " at the ends). The colour was light to dark brown, according to the incidence of the light. The grain, which was interlocked and alternating spiral, showed prominent resin-ducts, was smooth and cool to the touch, moderately coarse, with fibres of medium length.

In *transverse section* the wood was dark brown, with numerous fair-sized pores, evenly distributed. The rays were seen as numerous fine, light-coloured, parallel lines; the growth rings were well defined, 5 or 6 to the inch.

In *radial section* the wood was light to dark brown according to the alternating spirals of the grain. The pores were seen as numerous brown tubes with slight resinous contents. The rays appeared as reddish flecks; the rings were indicated by changes in the direction of the grain and variations in colour.

In *tangential section* the wood was yellowish-brown, with slightly darker markings indicating the growth rings. The pores were seen in the same form as in the radial section, and the rays as numerous thin red lines about 0·3 mm. long.

Results of Mechanical Tests

The results of the mechanical tests are summarised in the following table:

Summary of Results of the Mechanical Tests on Ekhimi Wood
(Piptadenia africana)

	Unit	Maximum.	Minimum.	Mean.
A.—*Transverse bending test (central loading)*:				
Maximum calculated longitudinal shear	*lb./sq. in.*	653	544	585
Modulus of rupture	,,	19,350	15,280	16,730
Fibre stress at elastic limit	,,	9,720	9,130	9,400
Modulus of elasticity	,,	2,390,000	1,915,000	2,144,000
Elastic resilience	*inch-lb./cu. in.*	2·30	1·89	2·15
B.—*Compression test along the grain (24 in. length specimen)*:				
Crushing strength	*lb./sq. in.*	9,560	8,700	9,060
Fibre strength at elastic limit	,,	5,720	5,625	5,670
Modulus of elasticity	,,	2,273,000	2,035,000	2,144,000
Elastic resilience	*inch-lb./cu. in.*	6·57	6·07	6·34
C.—*Compression test along the grain (8 in. length specimen)*:				
Crushing strength	*lb /sq. in.*	10,410	9,900	10,160
Fibre strength at elastic limit	,,	7,760	7,490	7,650
Modulus of elasticity	,,	2,310,000	2,130,000	2,209,000
Elastic resilience	*inch-lb /cu. in.*	10·61	10·20	10·38
D.—*Compression test across the grain*:				
Load at elastic limit	*lb*	8,500	8,400	8,470
Fibre stress at elastic limit	*lb /sq. in.*	2,104	2,080	2,090
E.—*Shearing tests along the grain*:				
Radial—				
Maximum load supported	*lb.*	8,540	6,020	7,380
Shearing strength	*lb./sq. in.*	2,204	1,595	1,958
Tangential—				
Maximum load supported	*lb.*	10,140	9,380	9,764
Shearing strength	*lb /sq. in.*	2,535	2,357	2,434
Specific gravity		0·734	0·700	0·718
Weight per cubic foot	*lb.*	45·9	43·8	44·9
Moisture	*per cent.*	8·43	7·37	7·95

Results of Working Tests

(1) *Sawing.*—Cutting with hand and power saws is fairly difficult along and across the grain and the work is unpleasant owing to the irritating dust given off.

(2) *Planing.*—Fairly good surfaces are obtainable with smoothing and Jack plane, but there is a pronounced tendency to " pick up " owing to the very definite alternating spiral grain.

(3) *Boring.*—Bradawl, gimlet, centre bit and twist drill give clear holes without splitting.

(4) *Nailing and Screwing.*—Nails and screws hold well, and they can be used close to the edge, both across and along the grain, without splitting.

(5) *Mortising and Dovetailing.*—The wood cuts moderately well in the mortising machine and gives excellent joints.

(6) *Working with Gouge and Chisel.*—The wood cuts fairly well but tears when cut against the grain, and is not very suitable for carving.

(7) *Turning.*—The wood turns readily but roughly, and has a fair surface when sand-papered. Unpleasant dust is given off which causes sneezing.

(8) *Glueing.*—Gives weak joints as the wood does not absorb the glue.

(9) *Polishing and Varnishing.*—A good finish is obtained.

(10) *Staining.*—The wood takes stains moderately well.

(11) *Shrinkage.*—Original width of plank $18\frac{1}{16}$ in. shrinkage after artificial seasoning $\frac{1}{4}$ in.

Remarks

The results of the tests on "Ekhimi" timber (*Piptadenia africana*) indicate that it is a strong, stiff wood of moderate toughness and hardness. It has a fairly high shear strength and crushing strength (especially across the grain in the latter case).

It is fairly hard to work and like "Aligna" (see p. 455) has a pronounced tendency to "pick up" owing to its grain. It also produces an unpleasant irritating dust when turned or sawn.

The wood has a good appearance when polished or varnished. It might be used as a substitute for cheap mahogany if the weight is not a disadvantage. It should be suitable for rough constructional work, doors, sills, etc.

Okwein (*Brachystegia spicæformis*)

The specimen received for examination consisted of a plank 12 ft. long, 11 in. wide and 2 in. thick, sound and free from cracks and knots. The grain was interlocked and alternating spiral, smooth to the touch, lustrous, with moderately fine and fairly long fibres. The heartwood was light brown and the sapwood of a mottled yellowish-brown tint.

In *transverse section* the wood was dark brown, with numerous well-defined pores, fairly evenly and densely distributed. The rays were invisible to the naked eye, but with a glass were seen as very numerous, fine, red lines; the rings were well-defined, fine, light lines averaging 14 to the inch.

In *radial section* the wood was light brown, and the pores were seen as narrow brown tubes, with slight resinous contents in the case of the heartwood. The rays appeared as numerous, fine, red flecks; the rings as indistinct fine lines.

In *tangential section* the wood was similar in colour and the pores were seen in the same form as in the radial section. The rays were visible as fine, red, parallel lines about 0·2 mm. long, whilst the rings were indicated by light wavy bands.

Results of Mechanical Tests

The results of the mechanical tests are summarised in the following table:

Summary of Results of the Mechanical Tests on Okwein Wood

(Brachystegia spiciformis)

		Maximum.	Minimum.	Mean.
A.—*Transverse bending test (central loading):*				
Maximum calculated longitudinal shear	*lb./sq. in.*	624	594	609
Modulus of rupture	,,	17,810	16,710	17,260
Fibre stress at elastic limit	,,	9,890	9,530	9,710
Modulus of elasticity	,,	2,441,000	2,32[illegible]	2,380,000
Elastic resilience	*inch-lb./cu. in.*	2·08	2·037	2·06
B.—*Compression test along the grain (24 in. length specimen):*				
Crushing strength	*lb./sq. in.*	9,720	9,150	9,435
Fibre strength at elastic limit	,,	6,060	5,830	5,925
Modulus of elasticity	,,	2,614,000	2,437,000	2,526,000
Elastic resilience	*inch-lb./cu. in.*	6·08	6·03	6·06
C.—*Compression test along the grain (8 in. length specimen):*				
Crushing strength	*lb./sq. in.*	9,600	8,910	9,293
Fibre strength at elastic limit	,,	6,860	6,700	6,783
Modulus of elasticity	,,	2,383,000	2,120,000	2,236,000
Elastic resilience	*inch-lb./cu. in.*	8·55	7·74	8·11
D.—*Compression test across the grain:*				
Load at elastic limit	*lb.*	6,100	5,850	6,000
Fibre stress at elastic limit	*lb./sq. in.*	1,532	1,478	1,510

E.—*Shearing tests along the grain :*

		Maximum.	Minimum.	Mean.
Radial—				
Maximum load supported	*lb.*	6,775	5,960	6,462
Shearing strength .	*lb./sq. in.*	1,694	1,490	1,616
Tangential—				
Maximum load supported	*lb.*	4,850	4,180	4,557
Shearing strength .	*lb /sq in.*	1,547	1,213	1,384
Specific gravity		0·719	0·686	0·708
Weight per cubic foot . .	*lb.*	44·9	42·9	44·2
Moisture	*per cent*	10·04	9·51	9·77

Results of Working Tests

(1) *Sawing.*—The wood is fairly difficult to cut with hand and power saws.

(2) *Planing.*—It is difficult to obtain a good surface with Jack and smoothing planes as the wood " picks up " badly.

(3) *Boring.*—Clean holes are obtainable with gimlet, bradawl, centre bit and twist drill, but the wood shows a tendency to split when large-size gimlets and bradawls are used.

(4) *Nailing and Screwing.*—Nails and screws can be driven in readily and they hold well with and through the grain, but the wood has a tendency to split.

(5) *Mortising and Dovetailing.*—The wood cuts moderately easily in a mortising machine, and strong joints are obtainable.

(6) *Working with Gouge and Chisel.*—The wood works well and is suitable for carving.

(7) *Turning.*—It turns fairly well and gives a good finish, but the prominent resin ducts are a disadvantage if the article is to be polished.

(8) *Glueing.*—The wood gives fairly strong glued joints.

(9) *Polishing.*—The wood requires filling, but it has a good appearance when polished.

(10) *Varnishing.*—It has an excellent appearance when varnished and makes a good mahogany substitute when stained.

(11) *Shrinkage.*—Original width of plank 12 in.; shrinkage after artificial seasoning $\frac{1}{16}$ in.

Remarks

Okwein (*Brachystegia spicæformis*) is a stiff, fairly hard wood, of good strength and of fairly high resistance to crushing and shearing. It works well with both machine and hand tools, with the exception of planes, where its tendency to " pick up " is a disadvantage. It has an excellent appearance and should make a good substitute for mahogany in furniture. It might also be useful for some classes of building and constructional work.

ALIGNA (*AFZELIA AFRICANA*)

The specimen received for examination consisted of a plank 10 ft. 6 in. long, 21 in. wide and 2 in. thick. The wood had warped laterally, but was free from cracks and showed only one knot. The heartwood was light to dark brown (according to the incidence of the light) and the sapwood greyish-brown. The grain was interlocked and alternating spiral, smooth and cool to the touch and moderately long-fibred.

In *transverse section* the wood was reddish-brown to purple with well-defined pores, densely and evenly distributed. The rays were seen as numerous pinkish-grey parallel lines ; the rings were well-defined lines, 5 or 6 to the inch.

In *radial section* the wood was light yellow when placed in one direction to the light, and in the opposite direction reddish-brown with light bands. The pores were seen as well-defined brown tubes with slight resinous contents. The rays appeared as long pinkish-grey flecks ; the rings were indicated by narrow dark bands.

In *tangential section* the wood was light yellowish-brown and of lustrous appearance. The pores were seen in the same form as in the radial section, and the rays as numerous minute pinkish-grey lines ; the rings were indicated by variations in colour and in distribution of the pores.

Results of Mechanical Tests

The results of the mechanical tests are summarised in the following table :

Summary of Results of the Mechanical Tests on Alighe Wood
(Afzelia africana)

		Maximum	Minimum.	Mean.
A.—*Transverse bending test (central loading)* :				
Maximum calculated longitudinal shear	*lb /sq in*	662	492	603
Modulus of rupture	,,	18 460	17,110	18,000
Fibre stress at elastic limit	,,	11 110	9,940	10,530
Modulus of elasticity	,,	2,186 000	2,120,000	2,157,000
Elastic resilience	*inch-lb /cu in*	2 92	2·42	2·67
B —*Compression test along the grain* (24 *in length specimen*)				
Crushing strength	*lb /sq in*	9,270	8,700	8,928
Fibre strength at elastic limit	,,	5,805	5,405	5,597
Modulus of elasticity	,,	2,220 000	1,990,000	2,129,000
Elastic resilience	*inch-lb /cu in*	6 40	6·04	6·21
C.—*Compression test along the grain* (8 *in length specimen*)				
Crushing strength	*lb /sq in*	10 870	9,870	10,273
Fibre strength at elastic limit	,,	8 440	7,650	7,900
Modulus of elasticity	,,	2,640 000	2,080 000	2,279,000
Elastic resilience	*inch-lb /cu in*	11 21	10·63	10·95
D —*Compression test across the grain*				
Load at elastic limit	*lb*	5,800	5,500	5,380
Fibre stress at elastic limit	*lb /sq in*	1,760	1,680	1,718
E —*Shearing tests along the grain* ·				
Radial—				
Maximum load supported	*lb*	7 700	5,140	6,348
Shearing strength	*lb /sq in*	2,214	1,460	1,887
Tangential—				
Maximum load supported	*lb*	9 970	8 450	9,040
Shearing strength	*lb /sq in*	2 473	2 113	2,260
Specific gravity		0 724	0 671	0·697
Weight per cubic foot	*lb*	45 3	41 9	43·55
Moisture	*per cent*	9 15	8 83	8·98

Results of Working Tests

(1) *Sawing.*—Cutting by hand and power saws is moderately difficult, and the wood is very unpleasant to work owing to the dust causing sneezing.

(2) *Planing.*—The wood picks up badly with Jack and smoothing planes, but a good surface is obtainable when planed tangentially to the growth rings.

(3) *Boring.*—Clean holes are obtainable with gimlet, bradawl, twist drill and centre bit, but the wood is slightly tough and difficult to bore by hand.

(4) *Nailing and Screwing.*—It is difficult to drive in screws and nails along and through the grain, but they hold well and the wood has but little tendency to split.

(5) *Mortising and Dovetailing.*—The wood cuts with difficulty in a mortising machine; strong joints are obtainable.

(6) *Working with Gouge and Chisel.*—A good finish is obtainable providing care is taken in direction of cutting. The wood is suitable for carving.

(7) *Turning.*—Turnery is difficult and the tools soon become blunted. The irritating dust is a great disadvantage. A fairly good finish is obtainable with sandpaper.

(8) *Glueing.*—Moderately strong joints are obtained.

(9) *Polishing.*—A good finish is obtainable if the wood is carefully filled.

(10) *Varnishing.*—The wood has a good appearance when varnished, similar to white mahogany.

(11) *Shrinkage.*—Original width of plank 21⅛ in.; shrinkage after artificial seasoning $\frac{8}{16}$ in.

Remarks

The results of the tests on "Aligna" timber (*Afzelia africana*) show that it is a fairly tough, moderately hard, strong and stiff wood. The wood is comparable with oak for toughness and hardness, but is considerably stronger and stiffer.

The difficulty of working (*e.g.* toughness and tendency to "pick up") and its irritating dust are disadvantages. It should be useful in furniture-making, where a sound strong wood is required and as a substitute (when stained) for mahogany. It would be suitable for solid doors, stair treads and general joinery.

AGBA (*PTEROLOBIUM SP.*)

The specimen received for examination consisted of a plank about 12 ft. long, 24 in. wide and 2¼ in. thick, slightly cracked and with several small knots, but otherwise in sound condition. The grain was of medium texture and straight, with fibres of fair length. The wood was light yellow, with yellow-orange pores.

In *transverse section* the wood was light brown, with numerous minute pores, fairly densely distributed. The

rays were seen as fine, light yellow parallel lines; the growth rings were fairly well defined, 8 or 9 to the inch.

In *radial section* the wood was light yellow, and the pores were seen as long, narrow, orange-coloured grooves with resinous contents. The rays appeared as whitish-yellow flecks, well defined and numerous; the rings were invisible.

In *tangential section* the wood was similar in colour, and the pores were also seen in the same form as in the radial section. The rays were just visible as numerous minute lines about 0·3 mm. long, whilst the rings were indicated by colour variations.

Results of Mechanical Tests

The results of the mechanical tests are summarised in the following table:

Summary of Results of the Mechanical Tests on Agba Wood
(Pterolobium *sp.*)

		Maximum.	Minimum.	Mean.
A.—*Transverse bending test (central loading)*:				
Maximum calculated longitudinal shear	*lb./sq. in.*	454·8	422·5	437·0
Modulus of rupture	,,	12,680	11,940	12,273
Fibre stress at elastic limit	,,	8,780	8,480	8,637
Modulus of elasticity	,,	1,455,000	1,379,000	1,416,000
Elastic resilience	*inch-lb./cu. in.*	2·83	2·66	2·74
B.—*Compression test along the grain* (24 *in. length specimen*):				
Crushing strength	*lb./sq. in.*	6,150	5,790	5,970
Fibre strength at elastic limit	,,	4,700	4,585	4,643
Modulus of elasticity	,,	1,510,000	1,450,000	1,480,000
Elastic resilience	*inch-lb./cu. in.*	6·18	6·14	6·16
C.—*Compression test along the grain* (8 *in. length specimen*):				
Crushing strength	*lb./sq. in.*	6,133	5,725	5,969
Fibre strength at elastic limit	,,	4,420	4,300	4,367
Modulus of elasticity	,,	1,301,000	1,194,000	1,242,000
Elastic resilience	*inch-lb./cu. in.*	6·26	5·76	6·05
D.—*Compression test across the grain*:				
Load at elastic limit	*lb.*	4,280	3,840	3,993
Fibre stress at elastic limit	*lb./sq. in*	1,064	955	993
E.—*Shearing tests along the grain*:				
Radial—				
Maximum load supported	*lb.*	4,360	4,220	4,310
Shearing strength	*lb./sq. in.*	1,090	1,055	1,078
Tangential—				
Maximum load supported	*lb.*	5,940	5,300	5,647
Shearing strength	*lb./sq. in.*	1,477	1,325	1,412
Specific gravity		0·533	0·491	0·509
Weight per cubic foot	*lb.*	33·3	30·7	31·8
Moisture	*per cent*	10·08	9·59	9·88

Results of Working Tests

(1) *Sawing.*—The wood cuts easily along and across the grain with hand and power saws.

(2) *Planing.*—An excellent surface can be obtained, but the wood has a slight tendency to pick up with Jack plane.

(3) *Boring.*—It gives good clear holes with gimlet, bradawl, twist drill and centre bit, and shows no tendency to split.

(4) *Nailing and Screwing.*—It takes nails and screws well along and through the grain, without splitting.

(5) *Mortising and Dovetailing.*—The wood cuts readily in mortising machine, and fairly strong joints are obtainable.

(6) *Working with Gouge and Chisel.*—It can be worked easily; the wood is of medium hardness and should be fairly good for carving.

(7) *Turning.*—It turns well, and has a good appearance and finish, but is unsuitable for making small articles on account of weakness in thin flanges.

(8) *Glueing.*—It takes glue well and gives strong joints.

(9) *Polishing and Varnishing.*—It has an excellent finish when polished or varnished but is too light in colour. The wood takes stain well, and has a good appearance when darkened and varnished.

(10) *Shrinkage.*—Original width of plank 32⅜ in.; shrinkage after artificial seasoning ¼ in.

Remarks

The results of the tests on "Agba" timber (*Pterolobium* sp.) show it to be of moderate hardness and strength; it is fairly stiff and not brittle. It has a good crushing strength, but is not so strong in compression across the grain or in shear.

This wood works well with all hand and machine tools, has but little tendency to split, is practically straight in grain, moderately long-fibred, and does not warp or check unduly.

The appearance is good, but the resin ducts are rather prominent. The wood is sometimes called "White

Mahogany," and when stained it should be suitable for use as a cheap substitute for mahogany, to which it bears a marked resemblance. It could be utilised for making cheap furniture, for general utility work, and for local building purposes where only moderate strength is required.

IROKO WOOD (*CHLOROPHORA EXCELSA*)

Two specimens of this wood from Nigeria were examined for comparison. Sample I was included with the preceding timbers in the consignment forwarded by the Conservator of Forests in 1918, whilst Sample II was received at the Imperial Institute in 1917.

Sample I.—This specimen consisted of a plank 12 ft. long, 20 in. wide and 2 in. thick. The wood was light greenish-brown (darkening on exposure) and was in sound condition, practically uncracked and free from knots. The grain was alternating spiral, coarse, open and lustrous.

In *transverse section* the wood was greenish-brown, with fairly evenly distributed pores visible to the eye. The rays were seen as close parallel lines; the rings as wavy grey lines which were not well defined.

In *radial section* the wood was of a lighter shade and the pores were seen as long brown grooves about 0·4 mm. wide, with occasional whitish contents. The rays appeared as long, whitish, parallel, wavy flecks, whilst the rings were indicated by light and dark brown shades.

In *tangential section* the wood was similar in colour to the radial section and the pores were seen as long brown grooves. The rays were just visible as minute brown specks; the rings were invisible.

Sample II.—This specimen consisted of a plank 16 ft. 9 in. long, 9 in. wide and 2 in. thick. The grain was generally similar to that of the preceding specimen (No. I), but more twisted. The wood was also similar to specimen No. I in colour, but showed dark brown patches.

In *transverse section* the wood resembled specimen No. I in colour and appearance, but showed slightly broader rays and denser distribution of the pores and soft tissue.

In *radial section* the wood was similar in colour to specimen No. I, but showed dark brown patches; the rays and rings resembled those of specimen No. I.

In *tangential section* the wood was similar to specimen No. I.

Results of Mechanical Tests

The results of the mechanical tests on the two samples are summarised in the table on next page.

Results of Working Tests

Sample No. I gave the following results :

(1) *Sawing.*—The wood cuts readily along and across the grain both with power and hand saws.

(2) *Planing.*—A fairly smooth surface is obtainable with Jack plane, but certain regions tend to tear owing to the alteration in the direction of the grain.

(3) *Boring.*—Good clear holes are obtainable with gimlet, bradawl, centre bit and twist drill, but there is a slight tendency to split.

(4) *Nailing and Screwing.*—Nails and screws can be driven in easily and hold well through and along the grain. There is a slight tendency to split.

(5) *Mortising and Dovetailing.*—The wood cuts readily in a mortising machine and strong mortised and dovetailed joints are obtainable.

(6) *Working with Gouge and Chisel.*—The wood can be worked with facility, but is not very suitable for carving.

(7) *Turning.*—The wood turns fairly well, but the fibres tear. Tools give a rough finish, but a moderately smooth surface is obtained on sand-papering.

(8) *Glueing.*—Strong joints are obtainable.

(9) *Polishing and Varnishing.*—The wood requires filling, but has good appearance.

(10) *Shrinkage.*—Original width of plank $20\frac{7}{8}$ in.; shrinkage after artificial seasoning, nil.

Sample No. II was harder and more difficult to work than sample No. I, and had a more pronounced tendency to " pick up."

Remarks

These two specimens of Iroko varied considerably in weight. The average weight per cubic foot of specimen No. I (containing 7·9 per cent. of moisture) was 34·9 lb.

Summary of Results of the Mechanical Tests on Iroko Wood (Chlorophora excelsa)

		Sample I.			Sample II.		
		Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.
A.—*Transverse bending test (central loading)*:							
Maximum calculated longitudinal shear	*lb./sq. in.*	414	384	402	517	392	455
Modulus of rupture	"	11,580	10,770	11,273	14,330	10,910	12,620
Fibre stress at elastic limit	"	8,560	8,400	8,497	9,690	8,230	8,960
Modulus of elasticity	"	1,551,000	1,486,000	1,520,700	1,408,000	1,361,000	1,385,000
Elastic resilience	*inch-lb./cu. in.*	2·52	2·44	2·47	3·56	2·49	3·02
B.—*Compression test along the grain* (24 *in. length specimen*):							
Crushing strength	*lb./sq. in.*	7,475	6,640	7,059	6,790	6,700	6,745
Fibre strength at elastic limit	"	5,625	5,480	5,535	4,970	4,805	4,887
Modulus of elasticity	"	1,425,000	1,310,000	1,335,000	1,260,000	1,230,000	1,245,000
Elastic resilience	*inch-lb./cu. in.*	9·74	9·37	9·59	8·26	7·87	8·07
C.—*Compression test along the grain* (8 *in. length specimen*):							
Crushing strength	*lb /sq. in.*	7,500	7,350	7,407	7,970	7,530	7,750
Fibre strength at elastic limit	"	7,140	6,560	6,877	5,910	5,770	5,840
Modulus of elasticity	"	1,188,000	1,125,000	1,146,000	1,320,000	1,201,000	1,260,000
Elastic resilience	*inch-lb /cu. in.*	16·91	14·35	15·49	10·82	10·37	10·60
D.—*Compression test across the grain*:							
Load at elastic limit	*lb.*	4,520	4,250	4,390	9,200	7,300	8,183
Fibre stress at elastic limit	*lb./sq. in.*	1,141	1,090	1,116	2,286	1,809	2,032
E.—*Shearing tests along the grain*:							
Radial—							
Maximum load supported	*lb.*	7,260	5,010	6,250	8,700	8,170	8,420
Shearing strength	*lb./sq. in.*	1,815	1,253	1,563	2,175	2,043	2,105
Tangential—							
Maximum load supported	*lb.*	5,070	3,092	4,073	7,500	5,630	6,780
Shearing strength	*lb./sq. in.*	1,268	773	1,016	1,875	1,408	1,695
Specific gravity		0·613	0·523	0·559	0·775	0·690	0·724
Weight per cubic foot	*lb.*	38·3	32·7	34·9	48·5	43·1	45·2
Moisture	*per cent.*	8·30	7·50	7·89	12·91	9·87	11·80

and that of specimen No. II (containing 11·8 per cent. of moisture) was 45·2 lb. The difference in the amounts of moisture present accounts to some extent for this variation in weight, but specimen No. II was distinctly harder than No. I.

The specimens do not show any marked differences in transverse bending strength and compression along the grain, but in compression across the grain and shearing along the grain No. II gives considerably better results than No. I.

The following table shows the results obtained at the Imperial Institute with these specimens of Iroko in comparison with the corresponding figures for two specimens examined by the Admiralty and quoted in Foster's *Notes on Nigerian Trees and Plants*, 1914:

		Specimens tested at the Imperial Institute.		Specimens tested by the Admiralty.	
		No. I.	No. II.	(1)	(2)
Weight per cubic foot, lb.[1]		34·90	45·20	48·92	49·02
Resistance to crushing along the grain, lb./sq. in.		7,059 7,407	6,745 7,750	8,954	8,400
Modulus of rupture, lb./sq. in.		11,273	12,620	33,194	34,951
Modulus of elasticity	Maximum	1,551,000	1,408,000	2,052,488	1,778,823
	Minimum	1,125,000	1,201,000		
	Mean	1,333,900	1,297,000		
Resistance to shearing along the grain, lb. sq. in.	Radial	1,563	2,105	792	835
	Tangential	1,016	1,695		

[1] *No figures are given by Foster for the moisture present in the specimens tested by the Admiralty.*

It will be seen from the above comparison that the specimens examined at the Imperial Institute possessed slightly less resistance to crushing along the grain and gave considerably lower values of modulus of rupture and modulus of elasticity than the specimens tested by the Admiralty. On the other hand, the shearing strengths of the Imperial Institute specimens are higher than those of the specimens examined by the Admiralty.

This Iroko wood (*Chlorophora excelsa*) is a very useful wood of good appearance, suitable for joinery and a variety of purposes. It is already well known in the English market, but could be utilised to a greater extent than at present.

SERICULTURE IN MESOPOTAMIA

The silk industry of Mesopotamia (Iraq), which was once flourishing, but later practically disappeared, is again being fostered by the local Department of Agriculture. An Officer was specially deputed in 1921 to undergo a course of training in sericulture in Kashmir, and cocoons reared under his supervision at Baqubah on the river Diala in the spring of 1922 were forwarded to the Imperial Institute for examination, the results of which are given in the following pages.

According to the *Administration Report of the Department of Agriculture, Iraq,* 1921, the silk industry first started in Mesopotamia in 1849 when the Turkish Government is reported to have interested itself in the planting of mulberry trees. It continued to progress until 1867, when a disease of the silkworms, believed to be flacherie, killed the industry and the "Bagdad Cocoon" disappeared from the market. In 1881 the work is reported to have been restarted by the Ottoman Public Debt Administration and schools were opened at various centres in Turkish territory. It was not until 1906 that serious attention was given to the matter, when two individuals imported ten packets of silkworm eggs with good results. This encouraged local cultivators to plant increasing numbers of mulberry trees, and at the outbreak of war in 1914 it is estimated that in certain villages there were enough trees to feed the worms from about 3,500 oz. of eggs, whilst the industry was also well established in other parts. Before the war, disease-free eggs were imported annually from Broussa and Diyarbakr, but during the war it was impossible to obtain supplies of such eggs, with the result that the local eggs became so badly diseased that silk growing was no longer profitable. The number of mulberry trees was greatly reduced during the war, and in 1921 it was estimated that the number then standing in the Diala area was barely 30 per cent. of that in 1914. It has been suggested that the Government could assist the industry by encouraging the planting of mulberry trees on a large scale along all the newly constructed canals. The Department of Agriculture is giving this matter attention

and mulberry seed on a fair scale is being sown on the Experimental Farms.

The cocoons received at the Imperial Institute were as follows:

"*Bulgaria.*"—These were smooth, firm cocoons, of oval shape and constricted in the middle. The cocoons were white to cream in colour both externally and internally. A few were pierced, and about one in three was slightly stained or mouldy within.

"*France.*"—These were large, smooth, firm cocoons, of oval shape and mostly constricted in the middle. They were white to cream-coloured both externally and internally. None of the cocoons was pierced, but a few were slightly stained or mouldy.

"*Italy.*"—These were smooth, firm, oval cocoons, constricted in the middle. The cocoons were of cream to pale pinkish-yellow colour externally and pale pinkish-yellow to bright yellow within. A few were slightly stained and mouldy, but otherwise the sample was in good condition.

"*China Golden Yellow.*"—These cocoons were smooth and firm, oval to round, pale yellow to golden yellow externally and of a deep cream tint within. A few cocoons were pierced, and several were somewhat stained and mouldy internally.

The cocoons were examined in the laboratories of the Imperial Institute with the following results:

			"Bulgaria."	"France."	"Italy."	"China Golden Yellow."
Average weight of cocoons		*grams*	0·5	0·8	0·6	0·4
Percentage of silk in cocoons (*i.e.* on removal of chrysalides and dirt)			45	42	49	46
Length of cocoons:						
Maximum		*in.*	1·6	1·8	1·6	1·3
Minimum			1·0	1·3	1·1	0·9
Mean		,,	1·3	1·7	1·35	1·1
Breadth of cocoons						
Maximum		*in.*	0·9	1·4	0·9	1·0
Minimum		,,	0·5	0·7	0·6	0·6
Mean		,,	0·65	0·95	0·7	0·75
Diameter of thread:						
'Bave'	Maximum	*in.*	0·0014	0·0014	0·0013	0·0012
	Minimum		0·0008	0·0008	0·0007	0·0007
	Mean		0·00105	0·00115	0·0010	0·0010
'Brin'	Maximum		0·00055	0·0006	0·00055	0·00055
	Minimum		0·0003	0·0003	0·00025	0·0003
	Mean		0·00043	0·00045	0·0004	0·00045
Moisture in cocoons as received:		*per cent.*	9·7	9·3	10·0	10·0

The cocoons were degummed by boiling for thirty minutes with a 1 per cent. soap solution, the degummed silk being in each case practically white and apparently normal in strength and general properties. The losses in degumming, expressed on the raw silk after being freed from chrysalides, dirt and moisture, were as follows:

	Per cent.
"Bulgaria"	28·0
"France"	24·8
"Italy"	30·0
"China Golden Yellow"	26·0

The cocoons were also examined by the Imperial Institute Advisory Committee on Silk Production, who furnished the following observations regarding their quality.

"*Bulgaria.*"—These are equal to ordinary, average Bulgarian cocoons of good quality.

"*France.*"—These cocoons appear to be a large hybrid race, resembling Broussa cocoons in general characters; the silk, however, as teased from the cocoons, appears to be somewhat brittle.

"*Italy.*"—Good, hard cocoons, containing plenty of silk.

"*China Golden Yellow.*"—A good quality of cocoon, but is of a somewhat "strong" colour.

The Committee stated that the cocoons were on the whole of very promising quality, and considered that reeling trials would be fully justified. Arrangements were therefore made for reeling trials to be carried out in France, and the results obtained are given in the following table:

Silk.	Colour.	Rendement.	Average size. *Deniers.*	Winding. *Tavelles.*	Elasticity. *Per cent.*	Tenacity. *Grams.*
"Bulgaria"	White	3·61	14·70	80/90	17/21	45/60
"France"	White	3·75	16·60	100 and more	18/22	50/70
"Italy"	Yellow	3·333	13·50	100 " "	18/22	40/50
"China Golden Yellow"	Yellow	3·558	14·30	100 " "	18/21	45/65

These results were considered by the Advisory Committee, whose observations on them may be summarised as follows:

(*a*) The rendement (or relative quantity of cocoons

required to produce a unit weight of silk) is quite satisfactory.

(*b*) The results of the tavelle or winding test (which are of special interest to the throwster) are satisfactory, particularly as regards the " France," " Italy " and " China Golden Yellow " silks.

(*c*) The elasticity, especially in the case of the " Bulgaria " silk, is fairly satisfactory.

(*d*) The tenacity of the silks is satisfactory, especially in the case of the " France " and " China Golden Yellow " varieties.

The reeled silks were of excellent appearance and quality, and were moreover reeled in sizes (13·50 to 16·60 deniers) which approximate to those most commonly required by the English silk trade, viz. 13 to 15 deniers. They were reported on by the Committee as follows :

" *Bulgaria.*"—A fine bony silk, not so white as the " France " sample but superior in every way to commercial Broussa silk.

" *France.*"—The very best type of white silk, fully equal to Cevennes silk.

" *Italy.*"—A fine silk of very brilliant colour, fully equal to the grade known as " Italian Extra."

" *China Golden Yellow.*"—A fine, bony silk, not so lustrous as Italian silk, but probably equal to it for certain industrial purposes.

The Committee considered that the reeled silks, and notably the " Bulgaria," " France " and " Italy " varieties, would be readily saleable in the United Kingdom, and valued them at the following prices in London (March, 1923) :

Silk.	Value per lb. *s.*	*d.*
" Bulgaria "	37	6
" France "	40	0
" Italy "	40	0
" China Golden Yellow "	38	6

The white silks are specially to be recommended as suitable for the United Kingdom market, since this class of silk is in wide demand by an important section of the English silk trade.

The results of the examination of these four samples of cocoons are very promising, and in the opinion of the

Imperial Institute Advisory Committee the continuance of sericultural work in Iraq is fully warranted.

WATTLE BARK FROM CEYLON

MOST of the supplies of the valuable tanning material, wattle bark, are produced in Natal, smaller quantities being grown in Kenya and Australia. An enquiry has been commenced by the Imperial Institute regarding the suitability of other parts of the Empire for wattle growing, and as a result five samples of bark from Ceylon have been received for examination. The ordinary black wattle (*Acacia decurrens* var. *mollissima*) was introduced into Ceylon over thirty years ago and cultivated at the Hakgala Botanic Gardens. Some years later an attempt was made to grow the plant for commercial purposes, but the margin of profit at that time apparently was not sufficient to justify large-scale operations. The tree is at present used in Ceylon as a windbreak and for green manuring on certain tea estates, so that it would appear that there should be no difficulty in cultivating it as a source of tanning bark.

The barks received from Ceylon, which had been obtained from trees growing at Hakgala, were as follows:

A. *Acacia dealbata*.—Age of tree 6 years 7½ months. This material consisted mainly of quills of fibrous bark, 1 to 1¾ in. long and ⅛ to 3/16 in. in thickness, together with a fair quantity of quills of twig bark, 1½ to 3 in. long and up to 1/16 in. thick. The outer surface of the bark was fairly smooth and light greyish-brown, the inner side being reddish-brown.

B. *Acacia decurrens*.—Age of tree 5½ years. This material consisted of pieces and quills of fibrous bark, ½ to 2 in. long and 1/16 to 3/16 in. thick, with a fair number of quills of twig bark 2 to 3 in. long and up to 1/16 in. thick. The bark was rather rough and dark greyish-brown externally, and dark brown on the inner surface.

C. *Acacia decurrens*.—Age unknown. This sample was composed of pieces of fibrous bark ¾ to 3 in. long, and ⅛ to ¼ in. thick. The bark was rough and greyish-brown externally and reddish-brown on the inner surface.

D. *Acacia mollissima.*—Age of tree 9 years 11 months. This material consisted of pieces and quills of very fibrous bark, 1 to 3 in. long and up to ⅛ in. in thickness, rather rough and greyish-brown outside and brownish-red on the inner surface.

E. *Acacia mollissima.*—Age of tree 7 years 9 months. This material consisted of quills of fibrous bark 1 to 2 in. long and 1/16 to 3/16 in. in thickness, together with a slight amount of twig bark in the form of quills 1½ to 3 in. long and up to 1/16 in. thick. The outer surface of the bark was fairly smooth and of a greyish-brown tint, whilst the inner surface was reddish-brown.

The samples were analysed with the following results :

		A.	B.	C.	D.	E.
Moisture	*per cent.*	10·5	11·0	11·1	10·8	10·7
Insoluble matter	" "	57·0	50·5	47·6	53·6	45·6
Extractive matter (non-tannin)	" "	9·3	7·1	7·7	8·1	10·3
Tannin	" "	23·2	31·4	33·6	27·5	33·4
Ash	" "	2·6	2·6	2·5	2·1	2·2
Tintometer readings red		8·3	4·6	5·6	6·9	4·5
Tintometer readings yellow		14·3	7·3	7·5	11·7	6·2

The barks furnished with calf skin pale pinkish-buff leathers of good quality which were similar to one another in character, being soft, plump and of firm texture, and showing the usual characteristics of wattle-tanned leather. The leathers produced by Samples A, C and E were about equal in quality and were slightly superior to those yielded by Samples B and D. In tannin percentage C and E were the best, whilst A contained the lowest amount.

The results of the examination of these barks show that with the exception of Sample A they were of similar quality to ordinary commercial black wattle bark from Natal, the price of which is £9 to £10 per ton (chopped) in the United Kingdom (June 1923).

The wattle bark of commerce, which is derived chiefly from the black wattle (*Acacia decurrens* var. *mollissima*) and also to a small extent from the golden wattle (*Acacia pycnantha*), contains from 25 to 45 per cent. of tannin, with an average of about 31 per cent. All but one of the present samples contained over 27 per cent. of tannin, and consignments of bark of similar quality should therefore be readily saleable in the United Kingdom. The bark of *A. dealbata* (silver wattle) (Sample A), although not

rich enough in tannin to be worth exporting, is of interest, as the quantity of tannin it contains is much higher than the normal amount recorded for *A. dealbata*, which is only 12 to 18 per cent.

COFFEE CULTIVATION IN TANGANYIKA

COFFEE is grown in Tanganyika both by Europeans on plantations and by the natives, the principal coffee lands being in the Moschi district, on the slopes of Kilimanjaro and in Bukoba. The area planted in 1912–13, apart from native coffee, was 12,008 acres, and in 1912 the exports amounted to 1,544 tons. The industry has revived since the war, and in 1921 3,828 tons, valued at £64,200, were exported.

Four samples of coffee from Bukoba were forwarded to the Imperial Institute by the Director of Agriculture in 1922, and the results of their examination are as follows:

I. "*Guatemala Coffee—Unhulled Buni.*"—This consisted of coffee in cherry. The cherries were very dark brown, whilst the enclosed beans were covered with a fairly loosely adhering, light brown seed-coat and were grey and translucent. A few pea-berries were present. The percentage of beans in the cherries was 58·6. The average weight of the cherries was 0·38 gram and of the beans 0·15 gram.

II. "*Guatemala Coffee—Hulled Buni.*"—This consisted of ungraded beans of irregular shape, covered with a tightly adhering, very light brown seed-coat. The beans, which were somewhat larger than those of No. I, were cream-coloured and mostly opaque, but a number of grey translucent beans were also present. The sample contained some broken beans and pea-berries. The average weight of the beans was 0·14 gram.

III. "*Robusta Coffee—Unhulled Buni.*"—This consisted of coffee in the cherry. The cherries were very dark reddish-brown in colour and had suffered considerably from insect attack. The beans, which were covered

with a tightly adhering, brown seed-coat, were very small, grey and translucent, and on the whole of fair appearance, although a number were black, shrivelled and poorly developed. Some pea-berries were present. The percentage of beans in the cherries was 59 per cent. The average weight of the cherries was 0·3 gram and of the beans 0·12 gram.

IV. "*Robusta Coffee—Hulled Buni.*"—This consisted of small ungraded beans of irregular shape, covered with a tightly adhering, brown seed-coat. The beans were cream-coloured and opaque, and a large number of them were broken. A few pea-berries were present. The average weight of the beans was 0·11 gram.

Samples Nos. I and III were husked at the Imperial Institute, and all the coffees were then submitted to merchants in London, who reported that both varieties would be suitable for the United Kingdom market and valued them approximately at the following prices, *i.e.* for husked beans on ordinary London landed market conditions :

Sample.	Price per cwt.
I	75*s*.
II	72*s*. to 73*s*.
III	64*s*. to 65*s*.
IV	63*s*.

It will be seen that the two coffees husked at the Imperial Institute were valued at somewhat higher prices than those husked in Tanganyika Territory.

The merchants stated that these varieties of coffee should not be shipped in the cherry, but should be husked in the country of origin. They considered that these coffees, particularly the Robusta variety, might also find a market in France, Holland, Belgium and possibly Germany, but stated that in such cases they should be shipped direct and not sent to London.

From the foregoing results it will be seen that there should be no difficulty in selling consignments of these coffees at satisfactory prices, but that they should be husked before shipment.

GENERAL ARTICLE

THE COOK ISLANDS AND THEIR RESOURCES

THE Cook Islands lie in the Southern Pacific, to the south-west of the Society Islands. Rarotonga, the most important island in the group, is 1,638 miles north-east of Auckland, New Zealand. Most of the islands were discovered by Captain Cook in 1777 on his second voyage to the South Seas. They were declared to be under British protection in 1888, and in 1901, together with various scattered islands farther north, they became part of the Dominion of New Zealand. The Cook Islands proper comprise Rarotonga, Mangaia, Atiu, Mauke, Mitiaro, Aitutaki, Takutea and Manuae. The other islands included under the administration, usually spoken of as the Northern Islands, are Palmerston, Suwarrow, Manihiki, Rakahanga, Pukapuka, Nassau, and Penrhyn. Niue, at one time included in the group, was placed under a separate administration within the Dominion in 1903. The seat of government of the Cook Islands (including the Northern Islands) is at Avarua in Rarotonga.

The area of the different islands, the population, according to the 1921 Census, and the distance of each from Rarotonga, are as follows :

	Area. *Sq. miles.*	Population.	Distance from Rarotonga. *Miles.*
Rarotonga	20	3,503	—
Mangaia	30	1,230	110
Atiu	22	837	120
Mauke	5½	578	151
Mitiaro	6	207	142
Aitutaki	7	1,373	140
Takutea	½	*	120
Manuae	2½	nil	120
Palmerston	1	83	277
Suwarrow	½	nil	525
Manihiki	2	432	650
Rakahanga	2	310	670
Nassau	½	*	690
Pukapuka	2	530	720
Penrhyn	3	376	740

* *Census figures not issued.*

The chief products of the islands are copra and coconuts, bananas, oranges, tomatoes, pineapples, coffee and pearl-shell. Most of the trade is carried on with New Zealand. The quantity and value of the chief exports in 1913 and in 1919–21 were as follows :

	1913.		1919.		1920.		1921.	
	Quantity.	Value.	Quantity.	Value.	Quantity	Value.	Quantity.	Value.
		£		£		£		£
Copra . *tons*	1,429	33,679	2,145	45,235	1,002	27,308	803	11,841
Coconuts .	578,600[1]	2,893	2,780[2]	1,490	5,287[2]	2,599	2,593[3]	645
Bananas *cases*	105,237							
bunches	1,784	35,700	31,494[4]	18,300	25,944[4]	12,859	52,388[4]	21,680
Oranges *cases*	107,728	16,852	70,087	36 030	109,480	36,490	57,169	22,343
Tomatoes *cases*	—	—	19,473	9,820	—	11,127	34,457	11,169
Pineapples *cases*	2,329	270	1,057	580	928	360	2,062	361
Coffee . *tons*	15	970	20	1,400	3½	448	76[2]	608
Pearl-shell *tons*	91	8,280	162	14,480	30	2,400	—	—

[1] *Number.* [2] *Sacks.* [3] *Cases and sacks.* [4] *Cases.*

Other products exported in small quantities from time to time include lemons, limes, mandarins, mangoes, cucumbers, kumaras (sweet potatoes) and taro (*Colocasia antiquorum*), arrowroot, vanilla, and lime-juice. The exports of the last-named product amounted to 7,230 gallons in 1906, but the output fell to 420 gallons in 1919, whilst none was exported in 1921. Candle-nuts were at one time shipped, 45 tons being exported in 1910; but the trade ceased because the natives considered that the price paid was too small when the labour of gathering and shelling the nuts was taken into account. Candle-nuts from the Cook Islands have been examined at the Imperial Institute (see this BULLETIN, 1920, 18, 25) and the Dominion Government have been furnished with a description of the methods successfully practised in other parts of the world for shelling the nuts with the minimum of labour.

The total value of the exports and imports in 1913 and in each of the years 1917–21, together with the proportion of the trade carried on with the different countries, expressed as a percentage of the total value, are shown in the following tables :

Exports

	1913.	1917.	1918.	1919.	1920.	1921.
Total value	£109,926	60,190	82,708	127,729	94,697	69,361
Countries of destination:	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
New Zealand	61·1	67·3	51·9	53·3	68·9	85·4
United Kingdom	25·3	—	—	7·0	2·6	—
United States	13·3	28·3	41·5	39·7	26·6	9·9
Tahiti	0·3	4·4	6·6	—	1·9	4·7

Imports

	1913.	1917.	1918.	1919.	1920.	1921.
Total value	£110,283	80,061	99,632	142,925	177,911	112,974
Countries of origin	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
New Zealand	75·3	77·4	71·1	64·3	67·1	86·1
United Kingdom	9·0	4·7	8·5	10·9	5·2	2·6
United States	9·0	13·8	15·4	19·3	24·6	8·3
Tahiti	2·9	1·4	2·5	2·7	2·2	2·5
Other countries	3·8	2·7	2·5	2·8	0·9	0·5

A report on the Cook Islands was made recently by Dr. R. S. Trotter to the New Zealand Government, a copy of which has been kindly furnished to the Imperial Institute by Sir James Allen, K.C.B., High Commissioner for the Dominion. The following information relating to the separate islands is taken from this report.

Rarotonga

Approached from the sea Rarotonga is one of the most beautiful islands in the south-eastern Pacific. Its rugged volcanic hills stand out boldly against the skyline on a clear day, and are clothed in verdure to their summits except where bold crops of rock and precipices show their grey faces. These hills are all climbable, and good views can be had trom their summits and during the ascent.

Between the hills and the sea-shore on the lowland, which apparently was at one time lagoon, coconuts and other tropical trees may be seen. There is a road around the island some 20-odd miles in circuit, which makes a pleasant drive, and gives one an opportunity of seeing the various villages and the general aspect of the local flora.

The island is surrounded by a protecting coral reef. There are two small harbours at the main settlement, Avarua, in which the trading schooners anchor and where they can remain safely except when strong northerly weather prevails. There is another small harbour on the

east side at Ngatangiia, which in former times was an anchorage for schooners and whence the Maoris are reputed to have sailed when they went to discover New Zealand. This anchorage appears at present to have become considerably silted up, but could be made into a good harbour if sufficient money were spent on it. Small boat passages are found at various parts of the reef all round the island where streams come down from the hills, but these are seldom used except for purposes of fishing.

At and about the settlements of Ngatangiia, Muri, Titikaveka, and Arorangi the water of the lagoon is fairly deep in places, at all stages of the tide and in all weathers. Considerable numbers of fish are caught in these parts by netting, poisoning, spearing, etc. Line fishing and trolling are only moderately successful as a rule outside the reef, but nearly all fish caught are edible. Shell fish of various kinds are found on the reef and in the lagoon, from crayfish to whelks. Good oysters could be cultivated. In the fresh-water streams shrimps are found, and eels of fair size are obtained from some of the swamps.

Rarotonga, from April or May until September or October, would make an ideal winter resort for New Zealand residents, as, during these months, the temperature is rarely high during the day and the nights are generally cool. Each settlement has a separate fresh-water supply laid on in pipes, but until reservoirs and filter-beds are constructed the condition of the water supply would not attract visitors of the most suitable class. Further, at the present time, the accommodation for visitors is poor. Apart from the "Whare Manuhiri" (Government owned) which is badly arranged for the comfort of visitors, there is only one European boarding house where a very limited number of people are accommodated. There are two other houses where visitors can stay in Avarua, but, under present arrangements, they are not suitable for family parties. Native houses in various parts can sometimes be rented for a season.

The chief crops produced on the island for export are coconuts and copra, oranges, bananas and tomatoes; but nearly all tropical and sub-tropical fruits can be cultivated, as well as several varieties of vegetables. Early potatoes

can be grown on some parts of the island. Yams, taro (*Colocasia*), dry taro, fei and uatu (mountain bananas, *Musa Fehi*), breadfruit, kumara (sweet potatoes), tapioca, arrowroot (*Tacca* sp.) and paw-paw (*Carica Papaya*) are the chief native foods produced. Sugar-cane and cotton grow well on the island, but the amount of land available for these crops is limited. Maize and ground nuts also do well, but are very liable to attack by rats. Rice could be grown in the swamps and Sisal hemp on waste lands. Vanilla grows freely, but is not cultivated. There are several trees, notably the oronga (possibly *Pipturus velutinus*), from the bark of which good cord can be made.

Labour is neither cheap nor very satisfactory, and the amount of land available for European settlement is very limited, whilst the system of tenure is unsatisfactory from a would-be settler's point of view. No one should go to the island with the idea of making a fortune out of planting or any other land industry, although something might be done in market gardening or poultry farming; but many people with limited private means could contrive to eke out a fairly comfortable existence in a climate which, on the east and south-east sides of the island, is never really a trying one. Phthisical people, however, should avoid the island, as such cases are apt to become rapidly worse there.

The rainfall is not excessive, but the humidity is great. The temperature, even in the hot season, December, January and February, seldom exceeds 92° F. In the cool season, May to September, the day temperature is often about 75°, and the night temperature rarely falls below 60°. The general variations are not great.

Clothing suitable for the climate can be bought locally, but at the present time is very dear. Cholera belts, cummerbunds, and such things are not necessary, but people should provide themselves with mosquito nets, and mosquito boots reaching nearly to the knee are very handy for verandah wear in the evenings.

The prices of commodities at the stores are not on an average much higher than those in New Zealand.

Frozen meat, butter, fruits and vegetables can be bought at moderate prices at the Government freezer,

and cattle of fair quality are sometimes killed on the island when the freezer supply of meat fails. Sheep can be kept from the departure of one steamer until the arrival of another, but they do not do well if kept long on the island; pigs and fowls abound, but high prices are charged for the latter.

The sale of liquor is under " State Control " so far as whites are concerned, and can be bought only at the bonded store. Importation by the individual is forbidden, the only person having authority to import being the Resident Commissioner. Prohibition exists for the natives, and it is an offence to supply a native with liquor; the result of this is a considerable amount of illicit traffic, particularly in " bush beer," and considerable drunkenness occurs. For medical purposes a native can be supplied with liquor from the bonded store on a permit from one of the medical officers.

There is a small Government hospital on the island, a post office and savings bank, but no quarantine buildings, isolation or infectious diseases hospital.

There is a wireless station from which messages can be sent to or received from New Zealand, Tahiti, United States and other places.

There is direct steamer communication with New Zealand and Australia, Tahiti and United States. The voyage to New Zealand occupies from five to six days, according to the route taken. Fares and freights are high.

Communication between Rarotonga and the other islands is mostly by trading schooner, but most of the group islands can be reached from time to time by a monthly steamer which calls at one or two of these islands on each trip. These communications are, however, infrequent and irregular, and a time-table of excursions for visitors is not possible. Some of the trips to the outer islands are pleasant, but others are the reverse. Landing on all the outer islands, except Penrhyn and Suwarrow, is at times difficult and dangerous.

The Maoris are by nature a kindly, courteous and hospitable people, and are affable towards visitors; but those who think them unsophisticated are liable to make grave mistakes.

If visitors or residents do not expect too much in regard to the amenities of civilised life they can have a fairly good time in Rarotonga, and if they have any inclination towards botany or zoology there is much on the island to interest them, and visits to the Government Experimental Farm may be of both interest and profit.

MANGAIA

This is the southernmost island of the group and from a white man's point of view probably has the best climate. It lies a little over a degree within the tropical belt. The geological formation is rather interesting. In the centre of the island are low round-topped hills, evidently of volcanic origin; the valleys between them usually terminate in large swamps. One of these swamps ends in a small lake which has its exit in the makatea and thence the water probably finds its way through caves to the sea as a small underground stream. As a barrier to these swamps and a block to their further extension and to the spreading of the valleys is a cliff of coral limestone locally known as the makatea. This huge barrier makes a complete circuit of the island, and in some places attains a height of between 200 and 300 feet, whilst its breadth may vary from a few hundred yards to nearly a mile. Over part of its area the makatea is bare rock tapering down in a gentle slope into myriads of outstanding pinnacles so sharp in many places and so irregularly pointed as to prove an almost insurmountable barrier for foot travellers not shod with some impenetrable material. Ordinary boots are cut to pieces in attempts to traverse this picturesque although uninviting range of jagged edges.

The whole formation is honeycombed with caves, many of which are large, long, irregular and many-branched. There are beautiful stalagmitic and stalactitic deposits within them, and several of them have been used in former days as burial-places.

A great part of the makatea is covered by red soil in which very fine kumaras are grown. At least seven varieties of this tuber have been noted, one of which is

particularly fine and has not the sweet taste which is objectionable to some people.

Ivirua and Tamarua, the two outlying settlements, are situated on the top of the makatea and a considerable part of the main settlement of Onerea also. From the lower settlement of Onerea, steps of coral limestone lead up the makatea to the upper settlement in several places, and there are descending steps on the other side to the swamps and valley land. Up and down these steps the produce of the island is frequently transported on the backs of ponies, and it is interesting to watch the animals picking their zig-zag way up and down. They seldom make a false step, and are quite as sure-footed at this work as the average mule.

Coffee is grown both on the top of the makatea and on the valley land inside, but the finest noted, which seemed to be of the Arabian variety, was on some of the fine black loam at the inner base of the makatea. Although poorly cultivated, and in some places not cultivated at all, this coffee, if kept until well matured, is of fine quality, and could compete successfully with many coffees on the market.

Various kinds of taro are grown in the swamps, whilst yams and other native foods grow well in most parts of the island. The limes are of good quality. As in most of the islands of the group, the guava has become a perfect nuisance, and requires more labour than is available for its eradication. Its habit of spreading broadcast over the best land is unfortunate for the islanders. The oranges of the island are of good quality, being luscious and juicy when fresh. Most tropical and sub-tropical fruits grow freely and many more than are already on the island could be grown ; there is, however, no incentive to such enterprise.

Between the makatea and the sea is a belt of more or less sandy and rockstrewn soil with pockets of phosphatic earth here and there (not commercially valuable) on which the best coconut trees are found.

There is a considerable variety of trees on the island, but most of the best and most useful have been cut down. On the hills, which are mostly bare, but for ferns and

scattered iron-woods (toa, *Casuarina equisetifolia*), it might be possible to grow pines, such as *Pinus insignis*, which in time would provide timber for making orange-cases, and so save the island from importing wood for the purpose. A serious difficulty in the way of successful afforestation is the inveterate carelessness of the native in regard to fire, whole clumps of beautiful iron-woods having been burnt out.

There are no harbours on the island, and the passages through the reef are far from good. At the main settlement, where most of the produce is shipped, the passage is often impossible, and canoes have at such times to go over the reef. In rough weather capsizing is frequent, and the work uncommonly arduous, at times dangerous, and often much delayed. Canoes sometimes have to wait for two hours before being able to get over the reef. This entails much work, too, as whilst waiting they have to be held in the surf on the shore side of the reef by sometimes as many as eight men. Shipping under such circumstances is trying to everybody and most unsatisfactory.

A secondary makatea formation girdles the island along the shore, with breaks here and there, and is evidently of more recent upheaval than the inner and larger makatea. It is covered in most places by ngangia, a sort of ti-tree (*Cordyline* sp.), one variety of which has a white flower and the other a yellow one. The wood makes a good fuel, and is much in request by the schooners for use in the galleys. It furnishes the best pointed spike for husking coconuts, and would make a beautiful wood for picture-frames, rules, etc. One can occasionally find a stick of it with a natural straight head, and if properly prepared makes a very fine walking-stick, of grey and black coloration with yellow and red patches whence the small branches have been cut off.

One of the most interesting articles to be obtained in Mangaia is the reru used for pounding tapioca, coffee, etc. The reru is made from the stalagmites found in the caves, from a certain kind of coral rock found inland, from basaltic rock, etc., and varies in colour and markings according to the variety of rock from which it is made.

Some are pure white, others black, others again reddish, whilst one may find all sorts of rerus with stripings of all ordinary rock colours. Some are close grained, others more crystalline, but all show an artistic finish, particularly those of ancient date, which reflects great credit on the skill and taste of the makers.

If the means of communication with the island were better, New Zealand people could spend a profitable vacation there. Those fond of traditional lore could get ample material to satisfy them. It is a most interesting island and the people are well worthy of study. Their language very clearly approximates to that of the New Zealand Maori and does not appear to be so much corrupted as that of the Rarotongan.

The water supply of the villages is poor and is mostly dependent on the Government tanks.

Atiu

Like most islands of the group, Atiu appears to be of volcanic origin. The centre of the island is made up of rounded and flat-topped hills, the latter having the general appearance of a plateau. The five settlements are on this flat land, which consists of red volcanic soil, and are all within short distances of each other. They are about 400 feet above sea level, and sometimes in the cool season when the wind is howling up the valleys one is glad of an overcoat.

The isle is girt by makatea and protected by a coral reef in which there are a few very small passages but no really good ones. Captain Cook landed by one of these.

There are fine valleys of fertile soil running down from the hills, and in most of the cuts in the hills are springs of good water. At three of these springs adjacent to the settlements the Government has put in concrete retaining walls for reservoirs and washing places for the people. The late Mr. Connal took a great interest in this work, which has been much appreciated and has been a great boon to the people, more particularly to the women folk, who formerly had often to sit among the red mud at the edges of the pools whilst doing their washing. This

red mud stains the white clothing like iron marks if not washed out at once.

At the lower end of the valleys are extensive swamps in which taro is grown, and there is one small lake in which large eels are caught. Between the hills and makatea proper are many patches of fertile land upon which almost any tropical fruit or food can be grown. Some of the swamps would make good rice fields.

The black oranges of Atiu are perhaps the best flavoured in the group. Excellent coffee is grown on the island.

There is a considerable extent of irregular makatea inland from the makatea proper, in which are numerous patches of rich soil on which coconuts, oranges, limes, etc., are grown. Grenadillas thrive excellently over much of this area and so rich is the soil that many of the vines climb up to the tops of trees sixty feet in height.

Paw-paws grow well in these parts of the island and are very useful as food for the numerous pigs which are kept there. At one time goats were abundant, but the dogs have killed most of them. Now that there are no bitches on Atiu, and the Island Council has forbidden the importation of dogs, it is to be hoped that the few remaining will soon die out—probably in five or six years—and the island will be free from these mongrel pests.

There are some very fine caves on the island; some are quite easy of access and easily explored. It is always desirable, however, to have a guide, as in some of them it is easy to get lost.

The possibilities of development of this island are considerable, as there is a fair amount of good land not yet planted.

It might be advisable to try *Eucalyptus rubra* on the hill-sides and plateau, as timber for box making would be useful to the islanders.

At the usual place for shipping fruit and landing foods the work is hard and two men have to be always on hand to hold on to the boat at the edge of the reef. The Government has blasted away the makatea here and made a place where the natives can get their boats and canoes to the water much more easily than in former years when

they had to be dragged up and down the makatea. Some sort of trolley-way from the land to the reef edge would be a great advantage to this island to facilitate the shipping of fruits.

When it is impossible on account of heavy seas to land or ship cargo at this place, shipping can usually be done from one or other of two localities farther round the island, and in both these places the makatea has been blasted to facilitate the landing and shipping of goods and produce. The road, too, has been so improved to one of these landings that motor wagons and carts can now readily get there.

The Atiuans worked hard and well when these improvements were being carried out, and also when the new water tanks and bathing and washing places were being made. Practically the whole of the materials for the latter had to be carried from the beach to the settlements, a distance on an average of between 2 and 3 miles.

There is a very fair road from the usual landing place to the settlements, and there are numerous tracks leading to the plantations, the taro swamps, and the fishing places. On some of these tracks over the makatea formation the travelling is very rough.

There is a considerable amount of good timber on the island; tou (*Cordia* sp.), tamavu (*Calophyllum inophyllum*), iron-wood, etc., and at one time there must have been many very large tamavu trees as the large blocks of that wood opposite one of the houses testify.

Here, too, and in several other parts of the island, places are marked out and bordered by huge stalactites which have been carried or dragged from the caves. Some of these blocks of stone are from 10 to 12 feet in length and a foot in thickness.

The Atiuans seem to have been a fighting race, and many of the finest recruits to the New Zealand forces during the period of the war came from this island. In fact at that time it was difficult to persuade any of the men and boys not to go, but to stay and work the plantations. Those one had to reject were very keenly disappointed, and some even swam out to the ship after the numbers were made up, in their effort to get away.

There is a sort of fortalice near Namaru's palace which is an interesting reminder of former fighting days.

The Atiuans are, like other islanders, hospitable to strangers, who are always very kindly treated on the island.

Mauke

This is a low-lying island compared with Rarotonga, Mangaia and Atiu, but is of similar geological formation to the last two. As in Atiu and Mangaia, there is no lagoon proper, but simply the more or less narrow strip of comparatively shallow water between the reef and the makatea which surrounds the island. Inland towards the centre of the island is the rising ground of red volcanic soil, between which and the makatea is a certain amount of swamp area. There are no valleys proper on Mauke, the land mostly sloping down gently from the raised centre towards the lower makatea.

There is a considerable area of unplanted land on this island, and the people seem to be less energetic than in Mangaia and Atiu, probably on account, to some extent at least, of having been freed from the dominion of their overlords of Atiu, and not having yet become quite used to the responsibilities of independence.

Although the proportion of good land on this island is considerable, there is a comparatively greater area of more or less barren land.

The oranges produced are of good quality and the climate being fairly dry a considerable number of bunches of sun-dried bananas are made. A fair inter-island trade is done in them, but there is no export to New Zealand. The people are skilful in the preparation of these dried bananas, or pieri, and the quality is good. The usual native foods are grown, and the supply is ample.

One of the two settlements in Mauke is situated near the shore and the other inland. The former is fairly well kept and has a certain air of tidiness about it, but the latter has an unkempt appearance. The road leading from the one settlement to the other is fairly good, but a short distance beyond the settlements the roads become

mere tracks. The passage in the reef at the settlement is not a good one.

There are some fine caves in the makatea about which, as in Atiu and Mangaia, many legendary tales are told.

Mitiaro

This is a low-lying island, long and narrow and quite unlike the usual roughly quadrilateral or triangular coral island. There are large areas of barren rocky land at each end of it, and a small area of good land, with volcanic soil towards its centre, surrounded by a large area of swampy ground stretching in various directions. On account of the small amount of cultivable land on this island food supplies sometimes become short.

There is a fair-sized lake on the island in which and in the swamps the island-famed Itiki or Mitiaro eel is found. This eel is found only in Mitiaro, whence it is taken to the other islands of the group. It is a dainty much appreciated on the schooners which now and then get supplies.

This island in the old days was subject to Atiu, but is now ruled by a native chief on behalf of the Government. As on all the islands, there is a native council which assists in the Government, and there are also native police.

The one settlement is kept in fairly good order and there is seldom much trouble on the island.

From a commercial point of view, Mitiaro is the most neglected of all the islands of the group, the steamers not calling there, as sufficient produce could not be shipped to make it worth while. The calls of schooners are infrequent.

Here, as in Mauke, a considerable amount of dried bananas, or pieri, is made, and one fancies that the quality is even better. There is a great rush for them in Rarotonga when it is known that a schooner has been to Mitiaro.

On this island both the true sandalwood and a bastard sandalwood, locally known as maramia, are found and the oil is much in request by the native women as a scent to mix with coconut oil for hairdressing purposes.

There is a considerable belt of makatea ground between the makatea proper surrounding the island and the central red soil and swamps, in which are some fine caves. This belt bears a fair variety of good timber trees.

There is now no white man on Mitiaro, but the local natives are most hospitable to strangers.

There is considerable communication between this island and Atiu and Mauke, big whale boats being used for these inter-island journeys.

AITUTAKI

The main island of Aitutaki is chiefly volcanic, whilst the lesser islets, scattered around the fringing reef, are of atoll formation. One side of the island has the reef close to the shore, as at Atiu, Mangaia, Mauke and Mitiaro; but on the other side the reef is far out and encloses a fine lagoon. This is the best island of the group for fish.

As a whole Aitutaki is a fertile island, although in the region of Mangapu there is a large area of unproductive land. Coconuts thrive well, and have been known to bear fruit in $3\frac{1}{2}$–$4\frac{1}{2}$ years from the time of planting. This, of course, is exceptional, but the average age for bearing is lower than in the other islands of the group. The Aitutakians consider that their oranges are the finest flavoured in the group, but, in reality, even their best are hardly equal to the Black Atiu orange for flavour. A considerable quantity of tapioca is produced on this island and is much in request by the people from other islands, as it is said to be of fine quality. Of late years, however, a blight has attacked the plants and has done considerable damage. Very fine pineapples are grown on the east side of the island.

Almost any kind of tropical fruit could be produced in Aitutaki, and the usual native foods are grown, but there is little taro, as the island is badly off for streams and water, and there are no extensive swamps.

Water can be obtained in many parts of the island by boring, and there are springs in several places along and near to the sea-shore.

The main settlement is on the western side of the

island, where there is a good boat passage up to the Government wharf through the lagoon. The other two settlements are on the eastern side of the island. When in rough weather the main passage is unworkable, landing can be effected on the east coast—with some difficulty, however—as after getting through the best passage in the reef, the lagoon water shallows rapidly towards the shore.

Most people who visit the island like the climate, but the great drawback is the irregular rainfall and the inadequacy of the water supply.

Takutea

Takutea is a small island lying about 16 miles off Atiu. It is uninhabited. Coconut trees have been planted on it by the Government, but they do not grow very well in most localities, probably because the island itself is of recent formation, is sometimes swept by tidal waves, and abounds with sea birds. The concrete water tank on it was destroyed by a tidal wave.

The Atiuans go over from time to time to collect the coconuts and to get the red tail feathers of the bosun bird which nests on the island. Fish are plentiful round the coast.

Takutea is of little financial value to the Government, and is not likely to be remunerative for many years, if ever.

Manuae

Manuae is an atoll and has a good lagoon. It lies about midway between Atiu and Aitutaki and really consists of two islands. It is leased by a private firm which employs hired labour to make copra and to do the necessary cleaning, planting, etc.

Fowls thrive well as the climate is inclined to be dry. Fish are abundant. The islands have suffered considerably at times from hurricanes.

The reef passage is not very good.

Palmerston Island

This island lies 270 miles from Rarotonga and is occupied by descendants of the late Mr. Marstera, to the

number of nearly one hundred. It is something of a shock on one's first visit to this island to hear nothing but a strange kind of English spoken. It would seem that the time has arrived when something should be done to alter conditions here, as the people seem in process of becoming degenerates. Transference to Penrhyn might help to solve the problem, as most of the inhabitants are connected with the Penrhyn Islanders, and an influx of a hundred or so people to Penrhyn would help in the development of that island.

The largest clam shells in these parts are found at Palmerston. The bosun bird breeds there, and its tail feathers are of some commercial value. Copra is the main product. Native arrowroot grows well. A schooner visits the island yearly to collect copra and in exchange brings food and other commodities.

The boat passage in the lagoon is not good, but the islanders are skilled boatmen.

Suwarrow

This island was at one time a small Admiralty coaling station, and was in occupation for some time by Messrs. Lever Bros., when experiments with Torres Straits shell were carried on, unfortunately without success. There is some pearl shell of good quality in the lagoon, but only a little sporadic diving is done. Messrs. A. B. Donald, Ltd. (Auckland), are the present lessees. The white ant is prolific.

Vessels may go through the passage and anchor near the jetty in the lagoon, but this is not a safe anchorage in northerly weather. The coast is dangerous about nightfall owing to the outcrops of reef.

Bird life is plentiful, and there is good fishing in the lagoon and round the coast.

There is no one permanently stationed there, and the commercial value of the island is small.

Manihiki

Manihiki is 650 miles from Rarotonga and is a typical atoll with a beautiful lagoon dotted here and there with

islets on which grow trees and shrubs. This is perhaps the prettiest of all the Northern Islands.

Its products are copra and pearl shell, both of good quality. The Northern Islands copra is superior generally to that of the lower group.

The pearl shell at Manihiki is of fine quality, there being little wormy shell owing to the thorough cleaning the lagoon received at the hands of Mr. Wilson, who at one time worked the lagoon with diving machines, and to the policy he instituted and which has been consistently followed since. Some really good pearls are sometimes found here, probably on account of the bulk of the shell brought up being fresh shell. It is not very large or thick, but is of good quality. Some very fine blisters are also found occasionally.

It would be a great advantage to Manihiki if a couple of rocks which make the passage at Tauturri dangerous at times were blasted out. This would not be costly. Schooners have at times to lie off the island for three weeks, unable to land or ship cargo on account of the heavy seas. This naturally ultimately becomes a tax on the islanders, though the traders always do their best for the people in this respect.

Rakahanga

This island is some 25 miles from Manihiki and is also an atoll. The people are of the same stock as the Manihikians and have similar qualities of natural courtesy.

Rakahanga is fortunate in having a spring of medicinal water on the lagoon beach at the settlement. This water is similar to that of Harrogate in England, and is of benefit to people suffering from rheumatism, asthma, certain skin diseases, etc. The Medical Officer and Resident Agent convinced the people the water was safe to drink. One spring is protected by a concrete wall forming a sort of well from which the water is drawn. The use of it has benefited the people considerably and patients from other islands have also done well there.

The passage in the reef here is perhaps one of the worst in the group on account of rocks at the entrance,

irregularity, rush of water from the lagoon and the undercutting of the reef.

There are many large coconut crabs at Rakahanga, as in all the Northern Islands, and these, together with the rats, are responsible for the destruction of a large quantity of nuts and of native foods.

A small variety of native foods is grown, but the staple food is the coconut. A few bananas and paw-paws are also produced, but the rats inflict much damage on them as well as on ground nuts, pumpkins and melons. In 1914 nearly all the native foods were destroyed by a hurricane.

Pukapuka

Danger Islands are perhaps the most isolated of the islands. They lie some 720 miles from Rarotonga and are rarely visited more than once a year by a schooner from the group. The people seem to be quite a different race from the other islanders and to speak a different language. The Pukapukans, however, know Rarotongan, which forms the medium of communication.

There are good taro beds here, particularly on the main island. A limited number of bananas are also grown. These islands suffered very severely from the tidal wave of 1914, all the orange and bread-fruit trees being killed. There is one lime tree remaining on Motu Kotava.

There is an old causeway which was built across one arm of the lagoon to connect by road the settlements of Roto and Ato.

These islands are evidently diminishing in size, as there are signs that the land surface has been much more extensive than at present, and tradition tells of a large population at one time, 20,000 on the main island and 10,000 on each of the other two.

Opposite the settlements on the main island is the tortuous boat passage in the reef, fit only for canoes or flat-bottomed boats. It is one mile from the entrance in the reef to the main settlement.

The copra produced is of good quality. There is shell in the lagoon also of good quality, but it is not at all

plentiful. The islanders make their fish hooks from the shell. A good deal of sinnet plait is also made.

The people of Roto own the land on the main island. Ato and Ngaki, the other settlements, each possess one of the other small islands.

The white ant is prevalent here and coconut trees are suffering. The people have been instructed in methods of controlling it.

Nassau

This is a fine island lying about 45 miles from Pukapuka. It is about 400 acres in area and has been almost entirely planted with coconuts. There are one or two small swampy places where taro can be grown, and native arrowroot would do well here.

The boat passage is not a good one, and there is no lagoon, but tidal water only between the reef edge and shore.

Penrhyn

This is the largest of the lagoon islands, the lagoon being about 108 square miles in extent and the reef about 40 miles round. There are three chief passages in the reef through which small vessels can get into the lagoon. The west passage has a depth of 21 feet and is about 40 yards wide. The schooners tie up at the wharf at Omoka. With the exception of Suwarrow this is the only island in the group where the schooners can tie up with any degree of safety during the hurricane season.

The people are of quite a different type from the Manihikians and appear to be of two distinct races, one being much darker than the other.

Copra and pearl shell are the main products of the island. Both are of good quality, but the pearl shell has deteriorated a good deal on account of its not having been dived for properly for some years. A large proportion of it is at present wormy. Some good pearls are found at times, and good blisters are fairly common.

The boatmen here are clever with their boats and the boats are usually very good ones.

The latitude of the settlement of Omoka is exactly 9° S., so it is a handy place for navigators to verify the

correctness of their instruments. The other settlement is 9 miles away, across the lagoon, where schooners can go close in shore and anchor on a sandy bottom. Both settlements are kept clean and each has two good 5,000-gallon water tanks. In Omoka the water is led by pipes from the tanks into the settlement.

The Resident Agent has commenced to reclaim a piece of land on the lagoon side, and when completed this work will improve the place very considerably.

NOTES

Imperial Institute: Committee of Enquiry.—In the last issue of this BULLETIN (1923, **21**, 363) reference was made to the appointment by the Duke of Devonshire, Secretary of State for the Colonies, of the Imperial Institute Committee of Enquiry.

Full information was supplied to the Committee regarding the work of the Institute, including the "Report on Operations" published as No. 1 (1923) of this BULLETIN.

The report of the Committee of Enquiry was referred to the Imperial Economic Conference. At a meeting of the Conference on November 2 the following resolutions were adopted :

1. "This Imperial Economic Conference recommends the adoption of the first of the two schemes for the future of the Imperial Institute and the Imperial Mineral Resources Bureau proposed in the Report of the Imperial Institute Committee of Enquiry, 1923, subject to the following modifications :

> "(i) That in order to ensure that the reconstituted Imperial Institute may in future undertake in its laboratories only preliminary investigations of raw materials for the purpose of ascertaining their possible commercial value, and to ensure that investigation or research of a more extensive kind may be referred to the appropriate authority, whether in this country or elsewhere in the Empire, there shall be formed a small Committee of the Governing Body, to be known as the 'Laboratory Committee,' consisting of the Comptroller-General of the Department of Overseas Trade (or his nominee), the Secretary of the Scientific and Industrial Research Department (or his nominee),

and a Fellow of the Royal Society, being a representative of that Society on the Governing Body of the Imperial Institute, who will supervise the laboratory work of the Institute and report thereon from time to time to the Governing Body.

" (ii) That, with a view to ensuring that in future the reconstituted Institute may have expert assistance in regard to finance, *e.g.* in establishment matters, a representative of His Majesty's Treasury be added to the new Governing Body and to the new Managing Committee proposed in paragraphs 100 and 101 of the Report of the Imperial Institute Committee of Enquiry."

2. " This Imperial Economic Conference approves the estimate of the cost of maintaining the reconstituted Institute as set out in paragraph 5 of the memorandum by the Secretary of State for the Colonies submitted to the Conference (I.E.C. (23)–18); and suggests that in order that the sum of £8,000 which is proposed as an annual contribution from the Dominions and India may be obtained, the ministerial representatives of the Dominions and of India advise their respective legislatures to contribute the following annual amounts for a period of five years:

	£
" Canada	2,000
Commonwealth of Australia	2,000
New Zealand [1]	1,200
Union of South Africa	1,200
India	1,200
Irish Free State	200
Newfoundland	200 "

In a report of the meeting of the Imperial Economic Conference at which the foregoing resolutions were adopted, published in *The Times* of November 3, it was stated that " Sir James Allen, on behalf of New Zealand, expressed his Government's regret that the Exhibition Galleries in the Imperial Institute were not, for financial reasons, to be continued."

Nickel Ores: Imperial Institute Monograph.—A monograph on Nickel Ores in the series of *Imperial Institute Monographs on Mineral Resources*, by W. G. Rumbold, Scientific and Technical Department, Imperial Institute, has just been published by Mr. John Murray.

[1] On the understanding that New Zealand is willing to raise this amount to £1,500, provided that the Exhibition Galleries of the Institute are retained.

The book, of 81 pages, is divided into three chapters, the first of which deals with nickel minerals, their mining, concentration and reduction, and with the properties, uses, value and world's production of the metal.

The second chapter deals with the known deposits of the British Empire, *e.g.* Ontario (Sudbury and Cobalt), Manitoba and Quebec, Cape Province and Transvaal, and New South Wales, Tasmania and New Zealand.

The third chapter deals with the foreign sources of supply, and describes the principal nickel deposits of Austria, Czechoslovakia, France, Germany, Greece, Italy, Norway, Russia, Spain, Sweden, Switzerland and Yugo-Slavia ; Asiatic Turkey, China, Borneo, Celebes, Japan, Philippine Islands, New Caledonia, Abyssinia, Egypt, Madagascar ; Cuba, Mexico, Porto Rico, Santo Domingo, United States, Brazil, Chile and Peru.

A map is provided showing the principal nickel occurences in the world, and the monograph concludes with a list of references to literature on nickel.

Australian Woods for Pulp and Paper Manufacture.—During the last three years an investigation of the possibilities afforded by Australian timbers for the production of paper-pulp suitable for the manufacture of newsprint has been carried out by the Institute of Science and Industry of the Commonwealth of Australia and the results have appeared in a paper entitled "The Manufacture of Pulp and Paper from Australian Woods," by L. R. Benjamin, which has been published as the Institute's *Bulletin* No. 25 (1923).

The work is divided into five sections, the first of which gives general information regarding the present position of paper-making in the Commonwealth, the raw materials available, the processes of manufacture, and the fuel and chemicals required.

It is estimated that during the next decade the annual demand for newsprint in Australia will reach 100,000 tons. At the present time about 120,000 tons of paper and pulp, of value £5,500,000, are imported each year, of which 70,000 tons consist of newsprint, 12,000 tons of other printing paper, 10,000 tons of wrapping paper, and 6,000 tons of writing and typing papers, whilst about 5,000–6,000 tons of wood pulp are imported for use in the Australian paper mills.

There are three paper mills and four board mills in Australia, all of which are situated in Victoria and New South Wales. The total annual output of these mills amounts to about 35,000 tons, comprising about 2,000 tons

of fine paper and 10,000 tons of wrappings, covers, etc., the remainder consisting of paper-board and straw-board.

No newsprint is manufactured in Australia, but there is a local market capable of absorbing the output of two paper mills, producing 100 tons of newsprint a day. The successful establishment of such mills depends on the possibility of obtaining large supplies of raw material from which suitable pulp could be produced at a cost of about £10 per ton.

The second section of the work consists of a summary of the information given in *Bulletin* No. 11 of the Institute of Science and Industry, entitled "Paper-pulp—Possibilities of its Manufacture in Australia" (see this BULLETIN, 1919, **17**, 415).

The third section gives an account of investigations into the suitability of the Australian timbers for the manufacture of wood-pulp and paper, which were carried out in the pulp and paper laboratory established under the Institute of Science and Industry at Perth, Western Australia. The work is dealt with under two headings, viz. (1) wood-pulping experiments, and (2) paper-making experiments.

The pulping trials were made by the process of digestion with caustic soda, and the following woods were examined. From NEW SOUTH WALES: blackbutt, *Eucalyptus pilularis*; mountain gum, *E. dalrympliana*; spotted gum, *E. maculata*, and coast ash, *E. sieberiana*. From VICTORIA: mountain ash, *E. regnans*; silver top, *E. sieberiana*; and woollybutt, *E. delegatensis*. From QUEENSLAND: candlenut, *Aleurites moluccana*; silky oak, *Grevillea robusta*; brush box, *Tristania conferta*; crow's-foot elm, *Tarrietia argyrodendron*; she-oak, *Casuarina torulosa*; kurrajong, *Sterculia discolor*; gum myrtle, *Angophora subvelutina*; swamp cypress, *Callitris glauca*; and mangrove, *Schizomeria ovata*. From WESTERN AUSTRALIA: karri, *Eucalyptus diversicolor*; jarrah, *E. marginata*; and marri, *E. calophylla*. From TASMANIA: swamp gum, *E. regnans*; stringy bark, *E. obliqua*; blue gum, *E. globulus*; gum top, *E. delegatensis*; and beech myrtle, *Fagus cunninghami*.

The general conclusions drawn from these pulping experiments may be summarised as follows. The woods of the eucalypts and most of the other woods examined contain, on the average, as great a percentage of cellulose as that of poplar, birch, spruce and other standard pulpwoods. In the case of the eucalypt timbers, the fibres have a length of a little over 1 mm. and a diameter of one-fiftieth to one-sixtieth of the length. The young wood is easily barked and chipped and is to be preferred to mature

timber, although in the case of *E. regnans* the mature wood can be pulped successfully without any variation in the conditions of digestion. Quickly grown wood is easily penetrated by the caustic alkali solution and is rapidly converted into pulp.

The most suitable woods with regard to yield, ease of pulping and bleachability of the pulp are the immature eucalypts of South-Eastern Australia, viz. *E. regnans*, *E. delegatensis*, *E. sieberiana*, *E. globulus* and *E. obliqua*, although *E. pilularis*, *E. diversicolor* and *E. calophylla* give a larger yield per cord and a larger output per digester than these. The Queensland woods, with two or three unimportant exceptions, are not suitable for the production of strong, easy-bleaching pulp by the soda process, but some of them, particularly *Aleurites moluccana*, *Tarrietia argyrodendron*, *Grevillea robusta* and *Callitris glauca*, can be used for the manufacture of kraft pulp. Indications were obtained that *Aleurites moluccana* and *Tarrietia argyrodendron* might give better results if treated by the sulphite process. On the whole, it is concluded that the eucalypts offer the most promising field for immediate exploitation.

The laboratory paper-making experiments, using a model Fourdrinier machine and a beater of 3 lb. capacity, were carried out with five typical eucalyptus pulps, viz. those of *E. regnans*, *E. pilularis*, *E. maculata*, *E. dalrympliana* and *E. diversicolor*. It was found that these pulps differ from most hard-wood soda pulps as they can be hydrated without difficulty and when hydrated are capable of forming paper of at least average strength. It is stated that eucalyptus pulps should not be regarded as mere fillers for giving opacity and bulk but as "half stuff" possessing considerable strength and therefore generally useful as paper-making materials.

In the fourth section of the report particulars are given of experiments carried out on a semi-commercial scale at the Barwon Paper Mill of the Australasian Paper and Pulp Co., Ltd., at Geelong.

The results of the pulping trials confirmed those obtained in the laboratory, and showed that the woods of the eucalypts are most efficiently pulped by a modification of the soda process, in which the chips are submerged in a weak liquor throughout the period of digestion, external heating being employed in order to avoid further dilution. By adopting this procedure instead of direct digestion with strong liquor, the yield is increased by as much as 60 per cent. and the strength of the pulp is greatly improved. The eucalypts of Tasmania and Victoria and young karri (*E. diversicolor*) give the highest yield of pulp

for equal weights of wood and are the most easily bleached. The yield of screened pulp for the most important woods was between 45 and 47 per cent. All the woods give a higher yield per cord than either spruce or poplar.

The paper-making experiments showed that mixtures containing 60–70 per cent. of eucalypt pulp are capable of furnishing paper of considerably higher bursting and tensile strength than those made almost entirely from spruce sulphite pulp under the same conditions. Moreover, papers made from mixtures containing about 60 per cent. of eucalypt pulp exhibit superior opacity and good finish. In the case of such papers, there is less shrinkage during drying than with papers containing a large proportion of sulphite pulp. Well-prepared eucalypt pulps are suitable for many purposes and especially for the manufacture of the better-grade printing, book, magazine and cartridge papers and the cheaper grades of writing and typing papers.

The fifth section of the report deals with the various economic factors which have to be taken into account in considering the possibility of establishing a wood-pulping industry in Australia.

The eucalyptus trees proposed as a source of pulp-wood reach a size suitable for cutting in from 8 to 15 years, whereas spruce and other pulp-woods require at least 40 years to grow to this size. Vigorous coppicing of the trees results in the production of dense stands yielding as much as 40 cords per acre in less than 10 years of growth. Protection of the forest from fire would be relatively simple and inexpensive. The system of "river-driving," which is commonly used for transporting timber from slow-growing forests in which the area to be logged is situated farther from the mill each succeeding year, could be replaced in the rapidly growing forests of Australia by a permanent railroad logging system as the average haul would be small and the quantity of wood to be transported would be large. It is considered that the cost might be much lower than in many cases of "river-driving."

Suitable labour is available in Australia for operating pulping plants and the cost would not be any greater than in the United States.

In the States in which the greatest reserves of pulp-wood exist, large power schemes are in course of development. Cheap hydro-electric energy is available in Tasmania, whilst in Victoria power generated from lignite at Morwell and cheap brown coal itself will be available in a year or two.

Estimates of the cost of production of pulp are given which are based on a small plant with a daily output of

10 tons of air-dry bleached pulp. Under these conditions and with fuel at 30*s.* per ton, wood at 40*s.* per cord, soda ash at £10 per ton, salt at £4 per ton, lime at 25*s.* per ton, power at 0·5*d.* per kilowatt-hour, and a minimum wage of £4 5*s.* per week, pulp could be produced at a little less than £13 per ton. Under more favourable conditions and with a larger output, the cost might be reduced to about £10 per ton.

It is estimated that the following quantities of pulp-wood (of 12 inches maximum diameter) are now standing. In Victoria, 2,000,000 cords within 100 miles of Melbourne; 3,000,000 cords within 250 miles of Melbourne; and total, 4,000,000 cords. In Tasmania, southern portion only, 1,000,000 cords. In New South Wales, 12,000 cords annually. In Western Australia, 20,000–30,000 cords annually. These quantities (except in the case of Western Australia) are exclusive of wood on alienated land.

The simultaneous operations of saw-mills and pulp-mills would effect much greater utilisation of the forests than is now possible and would assist the production of future supplies of mill timber by providing a market for thinnings from cut-over areas undergoing silvicultural treatment. Moreover, a certain amount of mill waste could be utilised for pulping in addition to most of the small and some of the defective trees.

It is considered possible that sufficient wood-pulp could be produced in Australia to supply the local paper-making industry with 6,000–10,000 tons per annum and also to develop an export trade. A paper-mill designed to manufacture printing paper and using 60–70 per cent. of Australian pulp and some imported pulp would have the advantages of a supply of cheap pulp, the absence of high freight charges, and the operation of a protective duty on imported paper. A combined pulp and paper mill would offer even better prospects.

The conclusions reached by the investigations described in this bulletin are summarised as follows: (1) An abundance of wood in the form of young re-growth is available for establishing the pulping industry; (2) the wood is easily pulped by a modification of well-known pulping processes, the cost of production being low; (3) the pulp is suitable for a fairly wide range of papers; (4) conditions are favourable for establishing a pulp-mill to supply at least 3,000 tons and possibly 10,000 tons of pulp annually for the local market, and an export trade is also possible; (5) there is little doubt that chemical pulp could be produced in Australia sufficiently cheaply to permit of its use in the manufacture of newsprint.

The bulletin is printed on paper made by the Institute of Science and Industry during the semi-commercial tests referred to on p. 494. It contains about 60 per cent. of chemical pulp made from Australian eucalyptus woods, 30 per cent. of imported chemical pulp and 10 per cent. of waste paper. A number of sample sheets are inserted at the end of the bulletin, composed of soda pulp made from various Australian timbers, in conjunction with about 30 per cent. of spruce sulphite pulp and 10 per cent. of waste paper.

Sisal Hemp Plantations in the Gold Coast.—Reference has already been made in this BULLETIN (1920, **18**, 560; 1922, **20**, 312) to the efforts which are being made to create a Sisal hemp industry in the Gold Coast.

In a *Memorandum* issued by the Governor in January, 1922, on the Sisal plantation at Accra, it was pointed out that the chief object in starting the plantation was to establish a new industry for a part of the country which is not adapted to the growth of cocoa and the oil-palm. The barren Accra plains were chosen for the plantation as they are unsuitable for most other crops and afforded a site which was near to a port and also to a supply of water. It was hoped that the local chiefs and others would be willing to co-operate with the Government by forming a Company to work the plantation, but this hope was not realised as the Gold Coast native is cautious and conservative, and disinclined to undertake a new industry until he is convinced that it will prove successful. The original intention was to plant an area of 3,000 acres, but this was subsequently reduced to 1,000 acres. A suitable site was found on the southern side of the Waterworks Railway about two miles west of the Accra Lagoon, and by September 1921 nearly the whole of the 1,000 acres had been planted. The plantation is intended to serve as the centre of an industry which it is hoped will be adopted by the local farmers as soon as they have appreciated the value of the crop. The plantation is to be provided with tram-lines for conveying the leaves to a central factory in which fibre-extracting machinery will be installed. It is considered that the crop of Sisal hemp, if sold at normal prices, should yield sufficient profit to enable the tramway system to be extended from the Government plantation to those of the local Sisal hemp farmers. In conjunction with the fibre plants, cassava and other food-crops are to be grown on the plantation for the provision of a food supply, and possibly for the production of power alcohol. The local farmers

will be encouraged to plant Sisal hemp, especially in the neighbourhood of the Government plantation, and advice and assistance will be afforded to them. The Government would be prepared to hand the plantation over to private enterprise on condition that the rights of the natives were adequately safeguarded.

In concluding his *Memorandum*, the Governor announced the formation of a Committee to draw up a concrete scheme for the future of the plantation on the lines indicated above.

The Committee presented their *Report* on March 29, and this has now been published (Gold Coast: Government Press, Accra, 1922). A short summary of its main features are given below.

It is expected that leaves will be ready for cutting on the plantation on January 1, 1924. The expenditure from the date of starting the plantation to December 31, 1921, was £14,609, and it is estimated that by the end of 1923 the expenditure will have amounted to £24,000. A portion of this will be recovered by the sale of foodstuffs which the Superintendent of the Plantation estimates will realise £4,000. (This estimate is regarded by the Committee as unduly optimistic.) The estimated expenditure of £24,000, however, does not include (1) compensation to farmers who were dislodged on the formation of the plantation, which will probably amount to £1,500, (2) the cost of building and equipping the factory, estimated at £5,941, (3) the cost of the tramways, £2,280, and (4) of water tanks and piping, £200, or (5) interest on the capital invested. These items will bring the total expenditure as at December 31, 1923, to about £35,000, after allowing for the revenue from foodstuffs.

It is estimated that the annual expenditure when the producing stage is reached will be £17,185, if a yield of 750 tons is obtained, or £19,485 in the case of a yield of 1,000 tons.

With regard to production, the majority of the Committee are of opinion that the annual yield of fibre will amount to ¾ ton per acre, whence the total yield of the plantation would be 750 tons per annum. The President (Mr. John Maxwell, C.M.G.) considers, however, that the yield will be at least one ton per acre, or a total yield of 1,000 tons or more per annum, this view being based chiefly on the information given in the Imperial Institute Handbook on *Cotton and Other Vegetable Fibres*, by Dr. Ernest Goulding.

The Committee consider it safe to assume that each plant will produce 170 leaves during a bearing life of

four years, *i.e.* an average of 42 leaves per annum. On this basis, the annual production of fibre per acre, assuming 888 plants to the acre and a yield of dry fibre of 3 per cent. of the weight of the leaves, would be almost exactly one ton. The cost of production, calculated from the annual expenditure mentioned above—which includes allowances for depreciation (10 per cent.), interest on capital (6 per cent.), and a sinking fund for repayment of capital (10 per cent.)—would thus amount to £19 9*s.* 8*d.* per ton. If the yield per acre should amount to only ¾ ton, the cost of production would be £22 18*s.* 3*d.* per ton.

The Committee are convinced that the climate and soil are quite suitable for Sisal hemp cultivation, but point out that the cost of labour is high and a supply is sometimes difficult to obtain. The plantation is favourably situated with regard to transport, and is in close proximity to the pipe-borne water supply for the town of Accra. It is felt, however, that although the quantity of water available will probably be adequate for the next few years, there is a danger that owing to the rapid increase in the population of the town it may not be sufficient subsequently, and it is recognised that in the event of a shortage the supply to the plantation would be among the first to be curtailed.

The Committee concur with the proposal that any profits which may be derived from the Government plantation should be utilised for the extension of the tramway system to the plantations of local farmers.

There is no prospect at present of the plantation being worked as a co-operative concern by African farmers. No definite suggestion has been received for private enterprise to take over the plantation, and, as the Government have agreed to return it to the chiefs as soon as the capital and interest have been recovered, such a proposal could not be considered unless the chiefs decline to take it over when the time comes. The Committee therefore recommend that the present system should be continued until the plantation is in bearing, when, with the results before them, the native farmers are likely to regard the proposition more favourably.

There are a number of appendixes to the *Report*, including the Minutes of the Meetings of the Committee, the Governor's *Memorandum* already referred to, statements and estimates of expenditure and revenue, and copies of correspondence between the District Commissioner, Accra, and the Accra chiefs.

Jamaica Pimento Leaf Oil.—An account of the progress

made in the development of the new pimento leaf oil industry of Jamaica is given by the Government Industrial Chemist in the *Annual Report of the Department of Agriculture, Jamaica*, 1921, recently received at the Imperial Institute.

This industry dated its commencement from the favourable report made by the Imperial Institute on the examination of a sample of pimento leaves (*Pimenta officinalis*, Lindl.) received from Jamaica in 1918 (see this BULLETIN, 1919, **17**, 298). Large-scale steam distillations of these leaves were subsequently carried out for the first time in the island in 1920, and in July of that year 30·5 lb. of the rectified essential oil, containing 95 per cent. of eugenol, were shipped to the United Kingdom, and sold at 10s. per lb. This oil was obtained by the steam distillation of 2,095 lb. of dried leaves which yielded 1·7 per cent. of oil. From August 1920 to June 1921 about 8 tons 14 cwts. of fresh leaves were distilled, furnishing altogether about 22·6 gallons of oil. Over 100 lb. of eugenol prepared from this oil were purchased by firms in the United States. The eugenol in the oil varied from 70 down to 32 per cent., the lower figure being attributed to the fact that the leaves were gathered during the cropping season (when the berries are rich in eugenol). During the greater part of 1921 monthly distillations were conducted of the leaves gathered from trees growing at different altitudes. The yields of oil, calculated on the dried leaves, varied from about 0·7 to 2·4 per cent. with an average of 1·6 per cent., and the eugenol content of the oil ranged from 41 to 93 per cent. Neither the yield of oil nor its eugenol content appeared to depend either on the month in which the leaves were collected or the altitude at which they were grown.

The apparatus employed by the Industrial Chemist in carrying out the distillations was a still consisting of an 18-ft. iron pipe into which steam at not less than 40 lb. to 45 lb. pressure was passed from a boiler. This equipment is stated to have given very satisfactory results.

Details are given of experiments which have been made in Jamaica in the preparation of vanillin from eugenol; the results, however, do not appear to have been altogether successful, and the manufacture of vanillin in Jamaica is unlikely to prove a commercial success unless it is conducted under the direction of an expert and modern economic methods of production are introduced. Under present conditions it would seem more profitable to export the oil, and further experiments in the cultivation of the leaves and preparation of the oil should

be undertaken with a view to ensuring a high percentage of eugenol in the oil. The manufacture of pure eugenol for export might also be considered, for it is improbable that the non-phenolic portion of the oil will have much, if any, commercial value.

Composition and Uses of Deodar Oil.—Samples of the essential oil distilled from the wood of the Indian deodar, *Cedrus Deodara*, Loud., were received at the Imperial Institute from the Forest Economist to the Government of India in 1914 and 1915 respectively. It was desired to find an economic use for this oil which could be produced from the waste wood obtained in the conversion of deodar timber into railway sleepers. The results of a chemical investigation of the oil at the Imperial Institute were subsequently published by the Chemical Society in a paper communicated by O. D. Roberts, F.I.C. (*Trans. Chem. Soc.*, 1916, **109**, 791).

More recently deodar wood oil has been examined by J. L. Simonsen, D.Sc., and M. G. Rau at the Forest Research Institute, Dehra Dun (*Indian Forest Records*, 1922, **9**, 123), who have obtained results which agree in the main with those obtained at the Imperial Institute. The oil employed by them was derived from logs seventy-five years old which furnished a yield of 2·5 per cent. of oil. The constants of the oil are compared in the following table with those of the two samples of oil examined at the Imperial Institute.

	Samples examined at the Imperial Institute.		Samples examined by Simonsen and Rau.
Specific gravity	0·9549 at $\frac{15°}{15°}$	0·9756 at $\frac{15°}{15°}$	0·9592 at 30°
Optical rotation α_D	+ 52·3° at 22°	+ 34·1° at 22°	+ 45·1° at 30°
Refractive index n_D	1·5195 at 21°	1·5225 at 21°	1·5203 at 30°
Acid value	5·6	4·5	1·6
Ester value	19·3	4·9	20·5
Ester value after acetylation	30·8	34·4	42·3
Solubility in 90 per cent. alcohol	Not soluble in 20 volumes	Miscible in all proportions	—

The pleasant aromatic odour which characterises deodar oil is due to the presence of from about 2 to 10 per cent. of a ketone, which Roberts stated was probably *p*-methyl-Δ^3-tetrahydroacetophenone, a compound not found previously in nature. This statement has been confirmed by the above investigators, who worked with a large quantity of the oil, and were thus able to isolate

the ketone in a pure condition and establish its identity by preparing many of its derivatives.

The principal constituent of the oil is a sesquiterpene, which is associated with a sesquiterpene alcohol; as, however, neither of these compounds yielded a crystalline derivative, it was not possible to characterise them beyond determining their physical constants. Other constituents which have been isolated from deodar oil are as follows: a phenol (unidentified), esters of hexoic, heptoic, and stearic acids (Roberts, *loc. cit.*), a free acid (unidentified), esters of butyric or isobutyric and hexoic acids (Simonsen and Rau, *loc. cit.*).

Samples of deodar oil were submitted by the Imperial Institute in 1915 to English and continental firms of soapmakers and essential oil distillers, who expressed the general opinion that a market could probably be found for the oil if it was offered at a low price. It was stated concerning a sample of oil which the Forest Chemist has had valued recently in England, that the oil might find a small market as a substitute for cedar-wood oil in soap perfumery, but that its value would only be 2*s.* 6*d.* per lb. At this price it was not considered that production would be remunerative.

The suggestion has now been made that it might possibly prove profitable to utilise the oil obtained by the destructive distillation of the wood as a timber preservative.

Cattle Industry of Rhodesia.—Until the last two or three years the local and Johannesburg markets have proved a sufficient outlet for the cattle surplus of Rhodesia. In 1916 Rhodesia commenced an export trade in cattle, mainly to the Union of South Africa, but owing to the steadily increasing number annually available and the stoppage in 1920 of the export of cattle to Europe from the Union, production in Rhodesia has now outstripped the demand with the result that serious financial embarrassment has arisen among cattle owners.

In view of this difficulty the Administrator appointed a Committee in 1922 to report to the Government on the possibility of finding markets for the surplus cattle and of improving the position of the cattle industry. Although this Committee has not completed its enquiries, it has been convinced from the evidence so far obtained that the situation is exceedingly critical and has therefore felt impelled to submit an interim report recommending immediate action by the Government in order to prevent the ruin of a large number of farmers and farming companies

(Report of the Committee of Enquiry in respect of the Cattle Industry of Southern Rhodesia, 1923).

That the presence of an excess of mature cattle has not been more severely felt hitherto is due to several causes. Ranches are still in the stage of stocking up and new settlers have been drawing on available stocks for draught and breeding purposes. The natives own nearly half the cattle of the country, and this reservoir, when not reduced by attractive prices or drawn upon through need of money for food in times of scarcity, is allowed to accumulate, for the natives regard cattle in themselves as a desirable possession and are not inclined to sell them, especially at an early age.

The Committee recognise that the precise number of cattle suitable for slaughter at any moment cannot be arrived at with exactitude, but they estimate that the present accumulated surplus of mature stock is about 250,000 head, a large proportion of which is available for slaughter. Information as to the number of cattle in recent years derived from statistics officially collected from the stock owners is given in the following table :

Date. 1st January :	Number of cattle.	Increase over previous year.
1916	840,910	92,858
1917	900,020	9,110
1918	1,083,943	123,917
1919	1,210,547	126,604
1920	1,331,284	120,737
1921	1,517,291	186,007
1922	1,754,141	236,853

At present there are about 2,000,000 cattle in Southern Rhodesia, but the country on the whole is still understocked, containing, it is estimated, only one-fifth of the total which it is capable of supporting, there being no shortage of pasture.

The present markets may be approximately assessed as under :

	Head per annum.
(*a*) Southern Rhodesia (slaughter stock)	90,000
(*b*) Union of South Africa (slaughter stock)	15,000
(*c*) Congo (slaughter stock)	3,000
(*d*) Congo (breeding stock)	500
(*e*) Mozambique Co.'s Territory (slaughter and breeding stock)	1,000

It is anticipated that the consumption of Southern Rhodesia will not exceed 100,000 head per annum for some time to come, and with increasing supplies nearer to the Rand the demand there for cattle from Southern Rhodesia is more likely to diminish than increase. The Congo market appears to be the only one susceptible of further development, and that only to a limited extent

as Northern Rhodesia possesses an advantage in its greater proximity.

The Committee are consequently of opinion that the most pressing need for Southern Rhodesia is the establishment of a frozen meat industry for export (primarily to Europe) as soon as the market improves.

Since it must take some considerable time for freezing works to be built and the essential storage and shipping facilities to be provided, and as under present depressed conditions no one with the necessary specialised knowledge of the freezing and export of beef and of the manufacture of by-products can be expected to commence operations in Southern Rhodesia without very special inducements and assurances, the Committee recommend that every possible assistance should be immediately granted by Government to competent capitalists to establish meat works. Their principal proposals in this connection are (1) remission of taxation for a period of years, (2) exemption from Customs dues, (3) exclusive rights of oversea export for a certain time, (4) bounties on meat exported, (5) support in requests for port facilities, (6) railway advantages and favourable ocean freights, (7) assistance from local authorities, (8) assurance as to duration of privileges, and (9) free grants of sites.

If these inducements are not sufficient, it is suggested that Government should guarantee the interest on the capital invested in meat works for a term of years as otherwise they will be faced with the necessity of erecting such works themselves to prevent the ruin of the industry.

It is also proposed that leading firms engaged in the meat industry should be invited to send representatives at the expense of the Government to examine the conditions on the spot, so as to enable them to form accurate and independent opinions as to the possibilities of the industry.

Only about one-quarter of the European-owned slaughter cattle is regarded as suitable for the export trade in frozen form, and it is doubtful whether any large number of the class suitable for chilling will be obtainable for some time to come. A large number of the cattle could only be utilised for boiling down for tallow and fertilisers, and perhaps also for extract, and any meat-freezing works should include boiling down on a greater relative scale than may be usual in other countries. An increasing proportion of the cattle is, however, of an improved type, and there seems no reason why the remainder should not also be graded up in course of time, especially as the assurance of a market would at once act as a great incentive to the improvement of quality. As, however, only cattle

superior to the average at present produced will be readily saleable in European markets, it is imperative that everything possible should be done to improve the average quality of the stock. In the opinion of the Committee this improvement is most readily to be secured by encouragement of the use of superior bulls and the Government may most effectively assist in this matter by granting loans to stock-owners for the purpose. Other suggestions made by the Committee for Government action with a view to improving the quality of the cattle include the appointment of stock advisers, loans for fencing, maintenance of stud farms, and education in the care and handling of cattle.

Clay Resources of Southern Saskatchewan, Canada.—An article on Saskatchewan clays has been received at the Imperial Institute from the office of the High Commissioner for Canada, and is summarised in the following pages.

At the instance of the Government of the Province, the Saskatchewan Bureau of Labour and Industries has been devoting its attention to the clay resources of Southern Saskatchewan with the aid of a ceramic engineer, Professor W. G. Worcester. Careful examinations of deposits have been made, and laboratory tests of a most thorough nature have been carried out in the Ceramic Laboratory of the University of Saskatchewan. Although the investigations are only in their early stages, the Bureau is desirous of bringing the information already compiled to the attention of those interested in the clay-working industry.

A special "Report on the Clay Resources of Southern Saskatchewan," by N. B. Davis, appeared in 1918 (*Canada, Dept. Mines, Mines Branch Rept.*, No. 468), which included an account of the collecting and testing of some 160 samples of clay. It is stated in this report that "the importance to the whole Canadian West of the clay resources of Southern Saskatchewan cannot be over-estimated. There is an abundance of high-grade clays suitable for the manufacture of stoneware, Rockingham ware and white earthenware. The fire-clays of the Eastern section will make a No. 2 grade of refractory, while the more plastic clays should find a use as bond-clays in the making of retorts and other special refractory shapes. They are also adapted to the manufacture of architectural terra-cotta, paving brick, and all varieties of burned clay products for structural purposes."

The first deposits to be examined under the Bureau

scheme were those offering possibilities of immediate development.

Pottery Clays of the Eastend—Ravenscrag District.—South of the Cypress Hills, the Frenchman River has cut a deep trench in the Tertiary and Cretaceous formations, and exposed the valuable refractory and semi-refractory clays which occur at the base of the Tertiary. One section exposed shows a total thickness of over 480 ft. of silts, sands and clays. For some 15 miles along the deep valley of the Frenchman River, the white band clays, from 20 to 25 feet in thickness, can be seen outcropping in the valley sides. The quantity of raw material here is practically unlimited. The geology of the district is simple. The prairie was an area of alternating, slow elevations and depressions. The sediments remained, approximately, flat-lying, hence the widespread and persistent nature of the clay formation. The white clays show considerable local variations, fat or plastic clays giving way to lean sandy ones within short distances. Here and there are concretions and stringers of iron oxide, but plenty of good clean water is available for washing the clays, which are highly suited to the manufacture of Rockingham, yellow ware, and a wide range of stoneware, including chemical stoneware, or clay products that are burned to vitrified bodies in a range from cones 5 to 9. Here are also heavy deposits of white clays of lower grade, but exceptionally good for the manufacture of sewer pipes and terra-cotta as well as paving bricks and tiles.

Tests have been made of two deposits near Eastend, and many carloads of clay have been shipped from them to Medicine Hat, Alberta, a distance of 450 miles, and there manufactured into a very creditable and extensive class of cooking ware and stoneware, which has found a market as far east as Montreal. One pit shows 20 feet of clay that burns cream-white at cone 1 or below, to a clear blue-stone at cones 7 and 9, with a total shrinkage of 14 to 15 per cent. Another pit reveals at least three good workable seams of clay, one of which stands cone 26 before deformation starts ; this clay can be used in the manufacture of low-grade refractory ware. This stratum should prove exceedingly valuable in the development of pottery and allied classes of clay products in the district. The other two seams burn to a creamy-white at cones 1 to 7 with low shrinkage and absorption, and will prove suitable for a general class of earthenware. To the south of the railway-siding at Knollys is a stoneware clay that burns to a beautiful cream colour, suitable for floor tiling, etc. The analysis and physical properties determined in the

Saskatchewan University Ceramic Laboratory show clearly the good properties of this particular deposit. There is very little difference in the chemical analysis of this clay and that of Roseville, Ohio, U.S.A., which supplies several large potteries, the Saskatchewan clay being its equal in every respect.

The clays of this district can be won by the open pit method, and are favourably situated in reference to water supply, transportation and fuel.

Clays of the Readlyn—Willows District.—These deposits are 150 miles east of the last. The clays are of the ball or semi-ball class, burning nearly white in some cases, and to a cream-white in others. They are less plastic and more refractory than the clays farther west at Eastend. For several years the Alberta Clays Products Co. has been mining clay in one place and shipping it to Medicine Hat, using it, first as a whole and later in part, in their sewer-pipe body. The upper part of the section exposed in the pit shows 10 feet of light grey clay, below which is 5 feet of grey and purple clay, and, still lower down, a seam of dark-grey purple clay, 3 feet thick. These seams should form the basis for such products as granite ware floor and wall tiles, insulators and similar wares, where a white body is desired. Other clays in the district are suitable for sewer pipes, terra-cotta, enamel ware and ordinary fire brick and stove linings.

On another property, there is a section of clay approximately 30 feet deep. The lower 10 feet is greyish white, somewhat stained with yellow along the cleavage lines, and with minute iron concretions distributed throughout the mass. A sample of this clay was tested in the laboratory, and, after washing, was found to give a better colour (light cream) than any of the imported standard ball clays, and it would prove highly suitable in the body mixtures for the manufacture of white ware and porcelain. Chemical analysis shows it to be comparable with the better grades of commercial clays. The deposit represented by the sample examined is directly alongside the Canadian Pacific Railway and four miles east of Willows station.

The mining of the Readlyn-Willows clays offers no difficulties ; there is an excellent plant site and rail facilities are favourable, the flat general rate on raw clay being 8 cents per 100 lb. Good water has in most cases been obtained by sinking wells. Where shallow wells have failed to supply a sufficient amount of water, a good supply will probably be obtained by deeper borings. The main lignite fields of the Province are within 155 miles by rail of the Willows field. Higher grades of coal from Alberta

will have to be hauled 340 miles, but lower-grade lignites occur within a short distance.

Burning with high-grade coals from Alberta is costly on account of the freight charges, but in one instance lignite has been used in up-draft kilns for burning common bricks, and, in another case, an inferior kind of lignite has been used by applying forced draft. Tests have shown that the lignites are ideal for making producer gas for power generation in a gas engine, and can also be used in powdered form for obtaining high burning temperatures.

Up to the present, the clay-working industry of Saskatchewan has been confined to the manufacture of brick and hollow tiles. There are several common brick plants scattered throughout the Province, while at Claybank and Estevan fairly large plants are being operated for the manufacture of face brick, as well as a very fine range of dry pressed face brick, which compares very favourably, both in colour and quantity, with any brick previously imported into the Province.

Considering the abundance of suitable clays in Saskatchewan, the time would seem to be opportune for the establishment of a plant in the Province for the manufacture of pottery, earthenware, or floor and wall tiles.

RECENT PROGRESS IN AGRICULTURE AND THE DEVELOPMENT OF NATURAL RESOURCES

In this section of the BULLETIN *a summary is given of the contents of the more important papers and reports received during the preceding quarter, in so far as these relate to tropical agriculture and the utilisation of the natural resources of the Colonies, India and the Tropics generally. It must be understood that the Imperial Institute accepts no responsibility for the opinions expressed in the papers and reports summarised.*

AGRICULTURE

Foodstuffs

Sugar Cane.—The results of extended research on root disease of sugar cane are given in a publication entitled *Researches on the Root Disease of Sugar Cane*, issued by the Department of Agriculture, Barbados. It was found that the disease was not confined to any specific type of soil, but occurred on both the black and red soils of the island. The fungus associated with freshly diseased and dying cane roots was either *Rhizoctonia solani* or *R. pallida*. In advanced stages of the disease the basal portions of the stem were found to be infested by one or other of these fungi, while in some cases a species of *Fusarium* was also present.

Inoculation experiments showed that both *R. solani* and *R. pallida* are parasitic, while *Fusarium* sp. and *Marasmius sacchari*, another fungus sometimes associated with diseased cane, gave negative results. The last-mentioned was isolated from dead roots and was never found in freshly diseased or dying cane roots. The disease is favoured in the field by conditions due to high soil temperature combined with a lack of moisture ; under the existing agricultural methods plant canes do not appear to be attacked to a noticeable extent by the disease, but ratoon canes under certain conditions are very susceptible. The following recommendations are made : (1) the planting of disease-resistant varieties ; (2) the planting of healthy cuttings from plants which are free from disease ; (3) suitable rotation of crops, so that the parasitic root fungi are forced to live saprophytically, thereby reducing their virulence ; (4) proper tillage and drainage, so as to provide good soil aeration and " root room," thus aiding the plants to maintain their maximum vitality ; (5) the proper trashing of fields of young plants and ratoon canes in order to conserve soil moisture and keep down the temperature. The publication contains an appendix dealing with the preparation of the media employed, a bibliography, and twelve photographs of the experiments.

Tea.—*Bulletin No.* 56, *Dept. Agric.*, *Ceylon* (1922) records experiments carried out to determine whether high cultivation exercises a controlling influence on the activities of the shot-hole borer (*Xyleborus fornicatus*), a question on which considerable divergence of opinion exists. The experiments, which were of a preliminary nature, were limited to the application of manures, but owing to the magnitude of the experimental error, the results are stated to be inconclusive. They indicate, however, that the best results may be expected from simple nitrogenous manures, particularly ammonium sulphate and sodium nitrate, and also from the application of lime, while organic and phosphatic manures have no beneficial effect. Potash in the form of potassium chloride gave a better result than that obtained from the best control plot, but where it was combined with nitrogen in the form of potassium nitrate this effect was not maintained.

Bulletin No. 60 (1922), issued by the same Department, deals with the damage caused to the tea bush by the shot-hole borer. Numerical data regarding loss of crops are not available, but the general damage to the frame and the loss of branches through die-back is considerable. Control measures are suggested on the following lines.

A powerful insecticide should be used at the time of pruning, and all the wood of the prunings should be burnt. In flushing tea a further control of the pest will result, if the branches which break when bent down, indicating the presence of the borer, are cut out and destroyed at a suitably early date after pruning.

Bulletin No. 54 (1922) of the same series, entitled, "The Treatment of Buried Prunings on Shot-hole Borer-infested Estates," records experiments which were undertaken, in view of the widespread practice of burying prunings on tea estates, to discover a method of treating the prunings to ensure the destruction of the insects and prevent their subsequent emergence from the ground. Treatment with artificial manures or with iron and copper sulphates was found to be of no value. Of the simple insecticides phenol alone showed any result, but in this case the effect was not marked. The best results were obtained with two commercial insecticides "Kerisol" and "Agrisol," but this treatment is too expensive. The conclusion is drawn that no artificial treatment of prunings to enable them to be buried wholesale, as removed from the bush, can compete from an economic point of view with the method advocated above by the department, in which all the leaves and small twigs are buried and the wood containing the infested galleries burnt.

The Indian Tea Association have issued a pamphlet of 260 pages entitled, *Factors affecting the Control of the Tea Mosquito Bug* (*Helopeltis theivora*, Waterh.). The subject is treated very fully in sections dealing with the bearing on the question of (1) points in the life history of the insect, (2) spraying, (3) climatic conditions, (4) variety of plant, (5) shade, (6) drainage, (7) cultivation, (8) manuring, (9) plucking, (10) pruning, (11) soil conditions, (12) potash manures, and (13) the chemical composition of the leaf of the plant. The relation of the chemical composition of the leaf to that of the soil is discussed and various other points of importance are dealt with. The publication contains many tables of analyses, plucking records and diagrams.

Rice.—*Pamphlets Nos.* 4 (1922) and 5 (1923), entitled "Correspondence and Report on Irrigation and Cultivation of Rice in Sierra Leone," issued by the Agricultural Department, Sierra Leone, deal with the question of extending the cultivation of "wet rice" to replace the "dry rice," which until recently was the only kind grown in that country. The advantages of growing rice on irrigated or swampy land are manifest in the better yields

obtained and the less exhaustive nature of the crop on the soil. Experts on rice cultivation in India were consulted, and the services of two native Indian rice cultivators were obtained to collect information on the possibilities of wet rice production in Sierra Leone, and to instruct the natives of that country in up-to-date Indian methods. The report is the result of the senior instructor's work, and indicates that the swamp soil is fertile, natural irrigation satisfactory, and the climate of Sierra Leone well adapted to the cultivation of rice. It also shows that the present native system of cultivation in the Skarcy delta is good, and that all that is required to increase the production of rice is that the natives should be induced to cultivate the undeveloped areas of swamp, and to this end be given security of tenure and freedom from unfair exactions. The method of cultivation practised in Sherbro is, however, defective, and some time was spent demonstrating to the people of that tract the Skarcy or Timine method. The natural conditions of the various districts, and the methods of cultivation, are discussed in detail in the pamphlets, together with criticisms of social conditions which influence agricultural development.

In *Bulletin No. 59, Dept. Agric., Ceylon,* " A Preliminary Report on Paddy Fly Investigations " (Dec. 1922), are presented certain data collected during a season's work at Anuradhapura in order to investigate (1) the life history and habits of the paddy fly (*Leptocorisa varicornis*) and (2) the efficacy of certain methods of control. The wild food plants of the insect were also examined, *Panicum colonum* and *Cyperus polystachyus* being the favourite breeding grounds. As regards control measures, hand nets gave good results. Winnows smeared with a sticky substance gave equally satisfactory results, but ropes saturated with kerosene or smeared with a sticky substance and dragged across the affected fields did not prove effective. Crushed sugar cane, placed on bunds as a bait, as suggested by Lefroy in India, was not found to attract the paddy fly, and a like result was obtained with the Philippine bait consisting of putrid meat hung out in muslin bags. The report indicates that much work remains to be done.

Citrus Scab.—*Bulletin No.* 1118, 1923, *U.S. Dept. Agric*, deals with the causes and the control of citrus scab or verrucosis, the parasitic disease of the twigs, leaves and fruits of many species of Citrus. The leaves in the very early stages of growth were found to be the most susceptible to the fungus, while by the time they reach half an inch in width they become entirely resistant.

Young grape fruits are extremely susceptible to infection after the falling of the petals, and become progressively resistant until they reach immunity at a diameter of about three-quarters of an inch. Scab infections are likely to occur whenever there is sufficient moisture at the time the parts are in a susceptible stage. Under such conditions infections developing in the hot, rainy summer months are as severe as those occurring during the cool weather of spring or autumn. In the nursery, citrus scab can be controlled readily by occasional applications of sprays, such as plain Bordeaux mixture or a mixture of this with an oil emulsion. This treatment is also practicable for the orchard. Burgundy mixture is less effective than Bordeaux mixture, and ammoniacal copper carbonate solution still less so. Lime-sulphur solution and other sulphur sprays are also less satisfactory than Bordeaux mixture. It was found that spraying after the fruits have attained a diameter of three-quarters of an inch has no effect on the control of the disease.

Oils and Oilseeds

Coconuts.—It is well known that coconut palms are most productive when they are grown on rich soils, in localities with a copious rainfall and within reach of sea-breezes, and that they grow most readily and naturally on almost pure sea-sand, impregnated with salt. The beneficial effect of salt on coconut palms has been shown in a series of experiments which have been carried out in Porto Rico, with a view to determining the effect of various manures (*Journ. Jam. Agric. Soc.*, 1923, **27**, 673). The best yield of nuts during the first eighteen months of production was given by a tree to which salt only had been applied. In experiments made in 1921 the check plot averaged 11 nuts per tree, while those that had been treated with salt yielded 45. Salt has been found so beneficial in these tests that much larger scale trials are being carried out in an older coconut grove, where records have been kept of the individual yields of several hundreds of trees for eight years. It is suggested that planters might apply 3 to 4 lb. of salt per tree per six months, distributing it well throughout the roots.

The leaf-mining beetle (*Promecotheca reichei*, Baly) does much damage to coconuts periodically in certain parts of Fiji (*Dept. Agric. Circ., Fiji*, 1922, **3**, 25). This beetle chews the under-surface of the leaves and its larvæ bore between the two surfaces, thereby causing brown patches up to 4½ in. long. The development of the larvæ is, how-

ever, checked by the two parasites, *Elasmus* sp. and *Chætostricha* sp., which are generally sufficient to overcome an outbreak of this disease.

Ground Nuts.—Four years ago the Cyprus Agricultural Department successfully grew a trial plot of ground nuts in Kyrenia and as a result several small private cultivations were made in the following years (*Cyprus Agric. Journ.*, 1923, **18**, 13). In the present season in this district the crop has covered 145 donums (48 acres) giving a yield estimated at 21,500 okes (27 tons), equal to nearly 150 okes per donum (1,286 lb. per acre). With careful cultivation the average yield per donum can be more than doubled. The Cyprus ground nut is stated to be mostly superior in shape, size and flavour to those imported from Egypt, and an export trade to the United Kingdom is now developing. This crop might be successfully cultivated in many other parts of the island, besides Kyrenia, where the soil is light and the water supply sufficient.

Chilian Molasses Palm.—A description of this palm (*Jubæa chinensis* = *J. spectabilis*), which is indigenous to certain parts of western Chile, is given in *Cotton Oil Press* (1922, **6**, 32). The tree, which rarely exceeds 37 ft. in height, grows slowly, and begins to produce about six or eight years after planting. The fruit is very similar in appearance to the coconut but is smaller in size. The palm grows away from the sea-coast and does not thrive near the sea or in salt swamps. The oil obtained from the fruits is rather different in appearance and in composition from coconut oil. It has a sweeter and more delicate odour and is liquid at ordinary temperatures. A nut weighs on an average 6·36 grams and is composed of about 60 per cent. of shell and 40 per cent. of kernel. The kernels, containing 4·68 per cent. of moisture, yield 68·4 per cent. of oil. The constants of the oil differ from those of coconut oil in respect of the saponification value (273·7), Reichert-Meissl value (8·8); melting point (11–12° C.) and solidifying point of fatty acids (18·7° C.). The residual cake is almost identical in composition with coconut meal.

RUBBER

Hevea

Latex Yield.—In *Bulletin No.* 55, 1922, *Department of Agriculture, Ceylon*, Messrs. Bryce and Gad deal with the various factors affecting the yield of latex.

In the experiments described, seed was selected from

No. 2 tree at Heneratgoda, which is famous for its high yield. No precautions were taken to prevent pollination by neighbouring trees. The seed was sown in nurseries and the one-year-old seedlings were planted out at the Peradeniya Experiment Station in July 1912. Tapping of the young trees was begun on April 1, 1921, and none of them was found to give a yield as high as that of the parent tree. The conclusions as to latex yield are as follows: (1) The offspring of a high-yielding tree are not all high yielders, but their mean yield is slightly higher than that of trees from non-selected seed; (2) there is a smaller proportion of low yielders than is found amongst trees raised from mixed seed, and the yield is more uniform than is the case on estates; (3) considerable variation occurs in the arrangement and distribution of the latex vessels in the cortex of the daughter trees; (4) the production of a high-yielding strain of Hevea would necessitate rigid selection over several generations; (5) yield is in close relationship with girth, number of latex vessel rows, and cortex thickness, the relationship being more marked than in the case of mixed plots, except as regards the number of latex vessel rows; (6) trees of largest girth, though they must have grown the most rapidly in earlier years, did not show the greatest increase in girth during the period of the experiments (April 1921–Jan. 1922); (7) there was no relationship between yield and girth increase during the period; (8) trees of greatest girth had generally more rows of latex vessels and thicker cortex; (9) when selected seed is used, the girth character can be used as a basis on which to select trees for thinning.

Preparation.—With a view to ascertaining the methods of preparing sheet rubber practised in the Besoeki district, a questionnaire was sent by the Besoeki Experiment Station to the managers of fifty estates. A summary of the information obtained is published in *Archief v. de Rubbercultuur* (1923, 7, 47). The chief facts brought out are as follows: the amount of rubber in the latex is low; the latex is usually diluted to 15 per cent. before coagulation, but most estates do not control dilution very seriously; on several estates rubber is prepared without using either antioxidants or anticoagulants; there is a large variation in the amount of acetic acid required to coagulate the diluted latex; the processes of rolling, soaking and dripping vary greatly; the type of smoke house possessing several rooms is generally used; trouble with mould formation is not serious; thickness and print are usually good.

Smoking.—Dr. A. J. Ultée, in *Archief v. de Rubbercultuur* (1923, 7, 60) gives an account of investigations on the smoking of rubber. The extent of smoking is judged by the percentage increase in weight of the rubber during the smoking process. This is known as the "smoke number." The author is of the opinion that the "smoke number" should vary between 0·5 and 0·75, but if bisulphite is added to the latex the smoke number can amount to 1·0 without the rubber appearing to be oversmoked. Analysis showed that at 100° C. not only moisture is lost but also some of the volatile constituents of the smoke. Some of the smoke compounds absorbed by the rubber are insoluble in acetone.

The smoking of rubber sometimes increases the viscosity of solutions prepared therefrom and at other times decreases it. No explanation of this is advanced.

Drying.—An account of the various factors affecting the rate of drying of rubber are given by Dr. de Vries in the *Archief v. de Rubbercultuur* (1923, 7, 95). It has already been shown by different investigators that the following factors retard drying: soaking the coagulum in water; strongly pressing the coagulum; overmilling the coagulum; spontaneous coagulation; keeping the coagulum before milling; coagulation by alcohol or heat; adding sodium sulphite or bisulphite to the latex; use of brackish water to dilute the latex; and coagulation by means of alum. In further experiments it has been found that the following factors decrease the time of drying: keeping freshly rolled sheet in alcohol or dilute formalin; keeping the freshly rolled coagulum in coal gas or carbon dioxide, and using dilute latex. On the other hand the time of drying is increased by keeping the coagulum in water, in 1 per cent. solutions of acetic acid, chinosol or caustic soda, or in a 5 per cent. solution of sodium sulphite or bisulphite. Micro-organisms are stated to exert an important influence on the time of drying. The quantity of hygroscopic substances present was found to influence the amount of moisture in the air-dry rubber but not the rate of drying. The cause of variation in drying time is thought to be due to variations in the physical structure of the whole mass of rubber and not to the formation of an impervious surface layer.

Brown Root Disease.—A preliminary account of observations on the fungi causing "brown root" disease is given by A. Sharples in the *Malayan Agric. Journ.* (1922, 10, 181). It is shown, from descriptions of the disease given by Petch and by Butler, that the characteristic

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symptom is an encrusting mass of earth and stems on the roots, intermingled with brown threads. The author was able to show that there are three fungi associated with brown root disease. It is suggested that the symptoms characterising the disease in its varied hosts are produced by all three fungi, which although different morphologically, resemble one another in possessing hyphæ capable of secreting mucilage when brought into contact with water.

FIBRES

Jute.—It is stated in the *Review of Agricultural Operations in India*, 1921–22, that owing to the trade depression throughout the world due to post-war conditions the area devoted to jute in North-East India in 1921–22 was only 1,515,000 acres as compared with 2,509,000 acres in the preceding year. The estimated yield was 3,982,000 bales of 400 lb. as against 5,885,000 bales in 1920–21. The yield per acre was 113 lb. greater than in 1920–21, but 145 lb. lower than the average of the previous ten years.

There are two species of jute (*Corchorus capsularis* and *C. olitorius*) cultivated in India, and the Bengal Agricultural Department has successfully isolated superior yielding strains of both of them. The non-chlorotic *C. capsularis* races R 85 and D 154, isolated from the Kakya Bombai variety, are still the highest-yielding forms, and this fact, together with the excellent quality of the seed produced by the Agricultural Department, has rendered them very popular among the cultivators. Two new races, D27, a pure line selection, and Dhal × Kg, a hybrid, have been tested on a large scale and have given yields as high as those of the varieties mentioned above. The Chinsura Green variety of *C. olitorius* again showed itself to belong to a separate class.

Selection and cross-breeding work is being continued and all the selections are now made on the basis of the absence of chlorosis as one characteristic, and the result is evident in the extraordinary growths made even in an unfavourable season by non-chlorotic cultures. It has been found that a non-chlorotic race can be sown on suitable land a month later than a chlorotic race and can therefore be grown over a much wider area than the latter. The work has thus succeeded beyond expectation in expanding the potential jute-growing tract.

Rotational and manurial trials have given a further striking demonstration of the beneficial effect of lime, phosphate and potash on jute grown on the arid red soils of Eastern Bengal (cf. this BULLETIN, 1917, 15, 283).

In Assam the Kakya Bombai selection has proved definitely superior to all the local varieties.

In the United Provinces 97 acres were devoted to jute in the Ganjar tract in the 1921 season ; the conditions in this region resemble those of large areas of Bengal. About 6,150 lb. of seed and 24,600 lb. of fibre were produced. Further development has since taken place in this area.

Paper-making Materials

Bagasse and Sugar-cane Tops.—In an appendix to *Bulletin No. 25 (1923) of the Institute of Science and Industry of the Commonwealth of Australia* on " The Manufacture of Pulp and Paper from Australian Woods " (see p. 492) reference is made to the possibility of utilising Queensland bagasse and sugar-cane tops for paper-pulp manufacture. It is well known that bagasse furnishes a useful pulp, but its employment for the purpose is limited by certain economic factors. At present the whole of the bagasse produced in Queensland is utilised as fuel and its cost to the pulp-maker would be proportional to the price paid for coal delivered at the mills. It is estimated that if the latter could be obtained at 35*s.* per ton, the millers would charge 10*s.*–12*s.* per ton ex mill for the bagasse (containing about 45 per cent. of moisture).

As sugar milling is carried on during part of the year only, whilst a pulping industry is normally continued throughout the year, provision would have to be made for the storage of the bagasse for about 100 days between the end of one milling season and the beginning of the next. Considerable space would be required for the storage of the material and difficulty would be experienced owing to the liability of the bagasse to undergo fermentation. This difficulty might be overcome to some extent by air-drying and baling the material. On taking into consideration these and other factors affecting the cost of production and transport of the pulp, it is concluded that the bagasse would have to be available at 5*s.* per ton in order to be able to compete with other materials. On the whole, it is considered that the possibility of using bagasse for the manufacture of paper-pulp would be confined to mills which crush not less than 60,000 tons of cane per season and which can profitably substitute coal or other fuel for the bagasse and afford to sell the latter at not more than 5*s.* per ton.

Experiments carried out by the Institute of Science and Industry regarding the suitability of cane-tops for paper-making have shown that the leaves are useless as they contain very little fibre, but that the tops, after removal

of the leaves, yield 40 per cent. of air-dry pulp of fairly good quality which can be easily bleached. This pulp is composed of fibres of average length 1·86 mm. and average diameter 0·017 mm. In order for the manufacture of such pulp to be profitable, it would be necessary for not less than 30,000 tons of the green tops per season to be delivered at a suitable site for a pulp-mill at about 3*s.* per ton. At present the tops are burnt in the fields and it appears that the value of the ash as a manure may approach the value of the raw material for paper-pulp. It is therefore considered that the utilisation of cane-tops for this purpose is not feasible.

Cotton

India.—An account of work on the improvement of Indian cotton has been given in the *Review of Agricultural Operations in India*, 1921–22. The area devoted to cotton in 1921–22 amounted to only 18,436,000 acres as compared with 21,341,000 acres in the preceding year, but the yield per acre rose from 67 lb. to 97 lb., the total estimated yield thus being 4,463,000 bales of 400 lb. each as against 3,601,000 bales in 1920–21. The exports of raw cotton were 2,981,000 bales in 1921–22 and 2,074,000 bales in 1920–21.

A prominent feature of the operations of the year under review is the work of the Indian Central Cotton Committee. The Committee has directed its attention to the improvement of the conditions of marketing and the prevention of abuses which in the past have been largely responsible for unsatisfactory market organisation, and has made recommendations regarding the restriction of transport in order to protect areas growing superior varieties from the importation of inferior kinds and the consequent admixture of the different types. The Committee has also made suggestions regarding the better regulation of gins and presses and has taken an active part in the establishment of co-operative market associations. A definite scheme has been formulated for technological research, including (1) the testing of new cottons for the Agricultural Departments ; (2) the study of the characters of the various Indian cottons with a view to eventually providing a sound basis for trade classification ; and (3) investigations into the relation between the physical characters of Indian cottons and their spinning characteristics. In order to raise the necessary funds for carrying on this research work, the Central Cotton Committee has proposed the levy of a cess of 4 annas per bale on cotton exported from British India by sea and on

cotton consumed in the Indian mills. These recommendations have been accepted by the Government of India and it is contemplated that a small technological research department will be started in Bombay. Another direction in which the Committee has shown activity is in the establishment of an information bureau for the collection and distribution of commercial and agricultural information relating to cotton.

Provincial Cotton Committees have been formed in all the cotton-growing Provinces, with the exception of Bombay, where a scheme for Divisional Committees is under consideration, and local cotton committees have been established in Madras. These committees form a link between the Central Cotton Committee and the Provinces and provide the Central Committee with local information. These various committees will be of the greatest importance in connection with the measures now being taken for the checking of adulteration and the improvement of marketing.

Bombay.—Efforts have been made during recent years to isolate pure strains of cotton and to introduce them into general cultivation, and considerable success has been achieved in the long staple areas of Southern Gujerat (Surat-Broach tract) and in the Southern Mahratta country (Kumpta-Dharwar tract).

The degeneration of the Broach crop, due to the spread of the inferior "goghari" cotton and the importation of short-stapled cottons for mixing, had proceeded to such an extent that in 1920 the Cotton Contracts Board found it necessary to exclude Broach from the staple cotton contract. Efforts were first directed to the production of pure types of Surat cotton and these types have been systematically distributed from the central farm at Surat, so that the Agricultural Department now controls 18,000 acres of private seed farms which are supplied with seed and regularly inspected and rogued. Special auction sales have been organised for cotton from these areas and the growers have obtained satisfactory prices for their crops. A keen demand has arisen for the seed, and for the 1922 season the Department issued sufficient for planting 200,000 acres and it was estimated that a further 200,000 acres would be planted with uncontrolled seed of the same selection. The "goghari" has now been largely eliminated from the Surat crop, and reports from trade sources have confirmed the view that great progress has been made in the re-establishment of Surat cotton. Encouraging results have also been attained in the north of the Broach district.

In the Kumpta-Dharwar tract, the Agricultural Department has established on a large scale improved types of Kumpta cotton (Dharwar I and Dharwar III) and an American Upland selection (Gadag I). A supply of seed is produced at the Department's farms sufficient to plant 10,000 acres of each variety and further extension is effected by co-operative seed societies and co-operative sale societies. In 1922 an area of 35,500 acres was planted with Gadag I, 38,000 acres with Dharwar I, and 5,000 acres with Dharwar III. Plant-breeding work is still in progress, and it is anticipated that even better types will be secured.

In Khandesh, the isolation of pure strains from the local short-stapled cotton (*Gossypium neglectum* var. *roseum*) is in progress, and it is hoped that by a similar organisation to that in Gujerat a marked improvement in the Khandesh cotton will result.

Sind.—The area devoted to American cotton in Sind was about 7,000 acres in 1920–21 as compared with 3,000 acres in the preceding year. It has already been shown that Sind possesses better possibilities than any other part of India for the cultivation of long-stapled cotton under irrigation. A strain of native Sind cotton has been obtained by selection which yields 16½ per cent. more lint per acre than ordinary Sind cotton. The question of future cotton research in Sind will depend on the decision reached regarding the construction of the Sukkur Barrage and the extension of canal irrigation (see this BULLETIN, 1919, **17**, 384).

Madras.—Work on the introduction of improved varieties into the Madras Presidency has been continued. In the " Northerns " tracts, a white cotton of good length and strength has been evolved from the local mixture. Seed of this strain, known as " Nandyal 14," has been distributed in the Kurnool District in quantity sufficient to plant 8,500 acres. It yields 25 lb. of seed-cotton per acre more than the local cotton and is expected to realise a premium of Rs.50 per bale.

In the " Westerns " tracts seed of an improved strain of the local cotton, termed " Hagari 25," has been distributed for planting 12,800 acres in the Bellary District. This strain yields 13 lb. of seed-cotton per acre more than the local mixture and commands a premium of Rs.13 per bale.

In the Tinnevelly tract, improved types of " karunganni," known as " Company " cottons (this BULLETIN, 1919, **17**, 394), have been planted on 200,000 acres in the districts of Madura, Ramnad and Tinnevelly. Company

cotton is also replacing rain-grown Cambodia and Uppam on the dry lands of Coimbatore as it is found to give a better yield. Seed for 4,000 acres was distributed by the Agricultural Department in the Coimbatore District ; the actual area planted with Company cotton in this district is estimated at between 80,000 and 160,000 acres yielding from 20,000 to 40,000 bales of 400 lb.

Cambodia cotton, a type of American Upland obtained from Cambodia, is grown on 118,513 acres, comprising 2,800 acres in Salem, 87,300 acres in Coimbatore, 1,730 acres in Trichinopoly, 9,000 acres in Madura, 14,556 acres in Ramnad, and 3,127 acres in Tinnevelly. It is cultivated mainly on land which has previously yielded precarious crops of rice, on favourably situated dry land, and on garden lands where it has been introduced into the rotation of crops. Improved strains are grown on 1,500 acres in Salem, 20,000 acres in Coimbatore, and 1,000 acres in Trichinopoly, and yield 25 lb. of seed-cotton per acre more than ordinary Cambodia of good staple.

Considerable difficulty is experienced in Madras owing to the importation of inferior cotton for mixing, and unless this practice is checked much of the Agricultural Department's work will be rendered useless.

The Cotton Specialist is endeavouring to improve Cambodia cotton by selection, and the inheritance of characters in crosses of *G. neglectum roseum* and *G. indicum* is also being studied.

Punjab.—The area devoted to Punjab-American cotton has declined during recent years but still amounts to about 500,000 acres. The yield in 1919 was unsatisfactory, but an improved yield in 1920 encouraged sowing for 1921. In that year, however, the crop in the greater part of the canal colonies was again unsatisfactory owing to causes which are not fully understood. This constitutes one of the most important cotton problems of India at the present time as Punjab-American is the most conspicuous example of the replacement of a short-stapled cotton by one with a length of about 1 inch. A more recent selection, 285 F, has shown great promise on the Lower Bari Doab Canal, but it is not yet established that it will prove suitable for the Lyallpur District.

United Provinces.—The area devoted to the Cawnpore-American cotton, known as CA9, in 1921–22 was restricted owing to the lack of an adequate supply of canal water, and amounted to 5,131 acres, as compared with 3,380 acres in the previous year and 8,100 acres in 1919.

A keen demand has arisen for the pure line selection, JN1, from the native Bundelkhand cottons. This cotton

is of $\frac{7}{8}$ in. staple and, although inferior to American in spinning value, it is greatly superior to the local kind, which has a length of only $\frac{5}{8}$ in. It was originally intended for Bundelkhand but will probably be grown extensively in the Lower Doab.

In the Muttra District good results have been obtained with the "Raya" selection from the hybrid K22 (this BULLETIN, 1919, 7, 178), and seed for about 1,000 acres has been distributed in the vicinity of the Raya cotton farm. Research work on Mendelian lines and the examination of cottons collected in the cotton survey are being continued, and proposals for a special cotton research section are under consideration.

Central Provinces and Berar.—Owing to the gradual disappearance of the longer-stapled cottons of the local mixture, the bulk of the Central Provinces cotton is now little better than Bengals. The seed distributed is still mainly of the *roseum* type and sufficient for 300,000 acres was issued for the 1922–23 crop. The cotton known as "Sindewahi Cross" has shown considerable promise and seed sufficient for 1,300 acres has been distributed. Seed for about 1,000 acres of Buri cotton was given out in Berar, and Cambodia is still under trial in the Nagpur and Chanda Districts. The problem of securing a cotton equal to *roseum* as regards yield but with less undesirable spinning characters is being seriously attacked, and the Akola farm has been definitely set apart for cotton research work.

Burma.—The survey of the indigenous cottons of Burma has made much progress, and the Wagale crop has been studied in more detail and several promising selections obtained. Crosses between Shan and Wagale, Broach and Wagyi, and Shan and Burma cottons are being further studied. Cambodia cotton is being grown experimentally in Sagaing, Monywa and Thayetmyo, and has given promising results; this variety has, however, proved unsuitable for Tatkon and its cultivation there has been discontinued.

Bengal.—Difficulty is being experienced in Bengal in connection with the proposed cotton survey as many districts do not grow any cotton on a field scale. A type of plant has been found at Dewanganj, similar to that described many years ago by Dr. Roxburgh as the Dacca muslin cotton, and seeds have been secured.

Assam.—A survey of the indigenous cottons of Assam has been started as a basis for future work.

Mysore.—Two types of cotton (Nos. 45 and 69) have been evolved from the Sanahathi crop of Mysore which have been favourably regarded by cotton spinners. These

promise a considerable improvement in yield, and seed has been issued for 250 acres. Extended trials of Dharwar-American cotton (Doddahatti) have been arranged for the 1922–23 season.

Baroda.—The Departments of Agriculture of Baroda and Bombay have co-operated for some time to ensure the establishment of uniform types in adjoining areas of their territories. The Bombay Department has supplied the Baroda State with the necessary selected seed and 22,000 acres of a selected type have been planted in the Navsari District. The Baroda Agricultural Department has now two seed depôts of its own and controls 300 acres of special seed areas.

Hyderabad.—Efforts have been successfully continued in Hyderabad to replace the local mixed cotton by the Bani (Hyderabad-Gaorani) type. This crop was estimated at 420,000 bales in 1921–22, of which 343,000 bales (said to be pure Bani) were produced in the Nandyal and Parbhani Districts. Measures have been taken to prevent the transport of cotton from one part of the State to another for mixing purposes. The best Hyderabad-Gaorani is now one of the most valuable cottons of India to spinners and meets with keen competition. The market value of the crop is reduced, however, by the condition in which the cotton is marketed, which causes a high blow-room loss in the mills; but it is anticipated that this defect will shortly be remedied by the establishment of new ginning factories.

In the *Annual Report of the British Cotton Growing Association for* 1922 it is stated that a Company, registered under the title of "B.C.G.A. Punjab Limited," is operating the lease of about 7,500 acres near Khanewal in the Montgomery District of the Punjab. The rainfall of this district is less than five inches, but the land is irrigated by the Lower Bari Doab Canal. The estate is being conducted as an object-lesson to the natives in growing improved types of cotton and in cultivating crops generally by superior methods. It is serving a useful purpose in this direction as neighbouring estates are following the methods adopted and are asking for supplies of cotton seed of the improved types. The crops grown on the Company's estate include 2,500 acres of wheat, 1,900 acres of cotton, and 700 acres of pulses. The cotton crop has proved a great success and large quantities of lint of the improved type are being shipped to the United Kingdom.

Queensland.—In the *Queensland Agric. Journ.* for January 1923 is given an interesting map of the cotton

areas of the State, together with statistics of acreage and production. In 1921–22 a total yield of 3,826,000 lb. of seed-cotton was obtained from 5,000 acres, the following quantities being contributed by the different districts: Rockhampton, 800,000; Wowan, 1,500,000; Gladstone, 80,000; Biggenden, 350,000; Dalby, 296,000; and Brisbane, 800,000 lb. For the 1922–23 season, sufficient seed was distributed to plant a total area of 131,160 acres in the various districts, viz. Rockhampton, 25,213; Wowan, 17,780; Gladstone, 8,080; Biggenden, 27,858; Dalby, 27,529; Brisbane, 22,489; and North Queensland, 2,211 acres.

Malaya.—In the *Malayan Agric. Journ.* (1922, **10**, 248) an account is given by H. W. Jack and W. N. Sands of certain experiments in cotton growing which have been carried out in Malaya.

The results of the earlier attempts to grow cotton in that country did not prove satisfactory from a commercial point of view owing to the production either of a low yield or of a crop of poor quality.

Experiments made about the year 1914 with Egyptian, American Upland and Caravonica varieties at the Kuala Lumpur and Batu Tiga plantations are stated to have given good returns, but details are not available. In 1921, Sea Island cotton was grown at the Kuala Kangsar Government Plantation, but, owing chiefly to late planting, only a small yield was obtained; the Superintendent, however, considers that the prospects for cotton-growing in this district are favourable. In 1922 Egyptian and Sea Island varieties were planted at the Serdang Government Plantation, but the results were unsatisfactory, apparently on account of unsuitable soil conditions. In some parts of the Peninsula, Egyptian, Caravonica, Indian and "kidney" varieties have been grown on a small scale by planters.

Small experiments have been made during the last two seasons by the Botanical Division of the Department of Agriculture with a view to the production of a supply of pure seed of selected Egyptian and Sea Island varieties for larger trials. Particulars are given of the results of the preliminary observations recorded in connection with these experiments.

On the whole, it is considered that long-stapled cotton of good average quality could be grown in Malaya with a fair degree of success, provided that sufficient attention were paid to the best time for sowing and to the cultivation and that systematic measures were adopted for the control

of pests. As the insect pests, and especially the cotton stainer, infest other plants, particularly kapok, roselle and hibiscus, it would be necessary either to destroy these or to control the pests found on them in localities in which cotton-growing is to be undertaken. Experiments have shown that the best results are secured on light, well-drained loams of average water-retaining capacity and that intensive cultivation must be practised instead of the extensive methods now adopted.

The best prospects for cotton cultivation are to be found in the eastern and northern states of the Peninsula, as these districts possess better defined wet and dry seasons and lighter soils than other parts of the country.

MINERALS

Aluminium

India.—The bauxite deposits of Rewa State are described by Kaikhushru P. Sinor, the State Geologist, in *Bull. No.* 3 (1923) *of the Geological Dept. of Rewa State*, with special reference to the possibilities of establishing an aluminium-producing industry in the State.

The principal bauxite deposits are on the Amarkantak plateau, near Amarkantak and Umergohan, and in the range of hills north of the Nerbudda River. Gneiss occupies the lower part of the hill ranges forming the plateau, while trap covers the whole of the plateau to a thickness of more than 1,000 ft. Between the trap and the gneiss are Lameta beds, which consist mostly of calcareous sandstones with chert and chalcedony segregations. The trap is in turn covered by laterites and here and there by rich beds of bauxite. Bauxite of high grade is found at Amarkantak, Umergohan, Chita, Miria, Harai and Mohodih, and the total quantity is said to be very large. Picked specimens of this bauxite contained from 62 to 66 per cent. of alumina, but the general quality ranges from 51 to 57 per cent. Bauxite of lower grade occurs in large quantities at many places in the State.

Sinor states that water suitable for generating electrical power is plentiful and conveniently situated, and that, alternatively, coal for generating power exists in quantity and is cheaply mined (see p. 527). The question as to which of these two sources of power would be the cheaper for aluminium reduction has not yet been determined.

Barytes and Celestite

Canada.—In *Publication* No. 570, 1922, *Canadian Dept. of Mines*, H. S. Spence describes the Canadian occurrences of

barium and strontium minerals. The bulk of the Canadian barytes, being of the hard crystalline variety, is at a disadvantage as regards grinding and bleaching compared with the soft material extensively mined in Missouri, U.S.A. Numerous mills have been operated in Canada at various times, but a large industry has never been established on account of insufficient attention being paid by manufacturers to the exacting requirements of the trade. At the time of writing there were no manufacturers of lithopone or other barium chemicals in Canada and the only barytes mill which was in operation supplied a paint works at Halifax, Nova Scotia. The chief deposits of barytes are in Inverness Co., Colchester Co. and Hants Co., Nova Scotia; in Sudbury and Timiskaming districts of N. Ontario; in Carleton Co., Frontenac Co., Lanark Co. and Leeds Co., S.E. Ontario; in McKellar Is., W. Ontario; in Hull Co., Labelle Co. and Pontiac Co., Quebec; and in the Golden Mining Division of British Columbia.

Interesting facts regarding the preparation of barytes for the market and the manufacture of barium chemicals are given, including flow-sheets of barytes mills in England and the United States.

No commercial deposits of witherite or strontianite (carbonate of barium and strontium respectively) are known in Canada.

Only four deposits of celestite (sulphate of strontium) of possible economic importance are known in Canada, all of which are in Ontario, viz. at Bagot, Renfrew Co.; Fitzroy, Carleton Co.; Loughborough, Frontenac Co.; and Lansdowne, Leeds Co. Of these, the first is by far the most important, and this deposit is now being actively developed. The celestite occurs in irregular, slab-like masses of radiating, columnar or fibrous crystals in brown dolomite (an altered Pre-Cambrian crystalline limestone), but at depth there is probably a true vein. At present only the clean mineral is obtained by hand-cobbing, but tests have been made by the Mines Branch, Canada, which show that the crude material can be satisfactorily concentrated by careful manipulation of jigs. A small mill has been erected to grind the celestite for use in the paint trade, since it contains so much barium sulphate as to render it unsuitable for sugar-refining.

Coal

India.—Further particulars of the coal-fields of the Rewa State which are described in the Imperial Institute Monograph, *Coal* (1920, p. 55) are given by K. P. Sinor in *Bulletin No. 2, 1923, Geol. Dept., Rewa State.*

No. 3 is the best seam in the Umaria coal-field, and is from 8½ to 13 ft. in thickness. The calorific value of the coals in Nos. 2 and 3 seams varies from 4,893 to 6,315 calories, the lower portion of each seam having a higher calorific value than the upper portion. R. J. W. Oates's estimate in 1902 of the total coal available in this field was 24,000,000 tons as compared with T. W. H. Hughes's estimate of 55,000,000 tons in 1885, but it is extremely likely that some of the Umaria coal seams extend up to the edge of the Korar-Kotalwar field, in which case the total available coal would be considerably in excess of the above estimates. The output for the Umaria collieries from 1884–5 to 1920, inclusive, was 4,552,180 tons.

The Korar and Johilla coal-fields remain undeveloped, but the latter possesses many advantages, and will probably soon come into prominence.

The area of the Sohagpur coal-field is given as 1,200 square miles—not including the coal-field of Korea and Jhilmili, which lies outside Rewa. Later developments than those described by Hughes and Reader in 1885 and 1900, respectively, show the main seam of this large field to be 27 ft. in thickness in some parts.

At Pakaria a large quantity of coal was quarried in 1921, the total thickness of coal mixed with carbonaceous shale being about 8 ft. This coal weathers badly. Samples of coal from the Semra trial pit, north-west of Pakaria, gave calorific values ranging from 6,110 to 6,580 calories. Coal is being quarried at Dhanpuri, near Burhar railway station, where the seam is said to be 27 ft. thick, with only 3 ft. of shale in the whole of the exposure. There are numerous outcrops of coal in this field, which vary considerably as to thickness, quality, accessibility, etc., but none of them appears to have been proved in depth.

The coal-bearing formations of the Singrauli coal-field cover 900 square miles. The best seams vary from 5½ to 8 ft. in thickness. The fixed carbon contents of the Naunagar and Parari coals are 49·42 and 52·72 per cent. respectively.

The coal of the Rewa State may be described as a good second-class coal. The demand for this kind of coal has increased considerably in recent years, and there is every reason to suppose that it will continue to increase. The immense store of coal existing in the Rewa State could be utilised in the establishment of industries which are dependent on cheap electric power, such as the manufacture of aluminium from bauxite, of carborundum from sand and coke, of graphite from anthracite, and of calcium carbide from lime and coke.

Copper

Cyprus.—The following notes are taken from the *Report on the Cupriferous Deposits of Cyprus,* by C. Gilbert Cullis and A. Broughton Edge (published by the Crown Agents for the Colonies, 1922).

The winning of copper was an important industry in Cyprus in Roman, and probably, also, in Phœnician times. During the last forty years a considerable amount of prospecting work has been carried out in various parts of the island, but nothing worthy of note was discovered until July 1914, when an American syndicate, having systematically explored by drilling iron-stained ground near the Skouriotissa monastery, encountered a mass of high-grade pyritic copper ore, and since that date they have blocked out an important ore-body by further drilling and underground development. From the system of ancient workings found in the locality, it is assumed that this mine represents one of the ancient mines of Soli.

The most important rocks connected with the copper deposits are the Idalian Series (sedimentary and of Miocene age) and the dolerite (" diabase ") and pillow-lavas (igneous). Although no copper deposits actually occur in the Idalian beds, they are, as will be seen later, genetically connected with them. The dolerite is confined to the elevated central portion of the Troödos range. In several localities it shows copper mineralisation, but the copper does not appear to be present in economic quantity. Serpentine, which is intrusive in the dolerite, does not seem to contain any copper, but has some valuable deposits of asbestos, promising deposits of magnesite and small showings of chromite. The pillow-lavas may possibly encircle the Troödos Mountains, but their principal development is along the northern margin of the range, where they form a broad zone of relatively low foot-hills between the sedimentary rocks of the Mesorian plain and the dolerite mountains. These rocks appear to have been poured out on the sea-bed as sheets of submarine lava. They are usually much decomposed, and are locally coloured green by chlorite (*terra verte* of Malounda and other places).

The important copper ores of the island occur at or near the upper surface of the pillow-lavas, where it is covered by the Idalian marls, and more especially where these overlying sediments are disposed in dome or anticlinal folds. The deposits are found principally along the northern margin of the Troödos massif. The primary ores consist of copper-bearing pyrite ; chalcopyrite is rare.

They are essentially sulphur ores from which copper may be recovered as a by-product, and are analogous to the cupreous pyritic ores of the South of Spain and of Norway. When the ore is pure, the sulphur content may reach and even exceed 50 per cent. The copper content is from 2 to 2½ per cent.; or, rarely, where there happens to have been secondary enrichment, from 3 to 5 per cent. The ore is sometimes massive, and sometimes disseminated in the gangue (country-rock). At Skouriotissa the ore-body forms a shallow cup lying in a hollow of lava and overlain by a syncline of marl. Elsewhere, it may form a low dome capping a cupola of lava and covered by an anticline of marl. The marl overlying the roof of the deposit is in the condition of dark brown umber, but assumes its normal chalky aspect a few feet above the upper ore-surface.

The authors conclude that the pyritic ore-bodies and disseminations represent replacements formed by the checking of ore-bearing emanations, in their ascent through the lava, by the mantle of impervious marl, which rests upon their surface. An analysis of a sample of the ore gave the following percentages: iron, 44·47; sulphur, 50·90; copper, 1·36; silica, 0·81; aluminium, 0·71; lime, 0·22; magnesia, 0·16; manganese, 0·01; arsenic, 0·018; lead, trace; zinc, trace; cadmium, nil, undetermined, 1·342. The company working the mine estimates the ore reserves at 6 million tons.

"Devil's mud" is the miners' name for a peculiar soft crumbling material found underlying the ore-body in certain parts of the mine, notably on the 820-ft. level for some distance on each side of the No. 1 shaft. A sample from this level assayed 2·12 oz. of gold and 12·96 oz. of silver per ton. The material consists of 30 per cent. of soluble salts, principally of iron and copper, the remainder being fine slime and siliceous grit.

The Lymni Concession lies in the foothills east of Polis (Paphos) and extends down to the shores of Khrysokhou Bay. It has extensive old workings, believed to be Roman, and large accumulations of slag. Modern explorations commenced in 1882. At present the mine is being actively prospected by the Cyprus Sulphur and Copper Co., Ltd. The underground workings have revealed a large body of rock, through which copper-bearing pyrite is disseminated. Westervelt in 1910 estimated that between the surface and the bottom of the Fassoti shaft (410 ft. below the old lake bed) there were 2½ million tons averaging 1·25 per cent. of copper, and 19·5 per cent. of sulphur (*Imperial Institute Monograph on Copper Ores*,

p. 46). Under present conditions this class of ore could not possibly be worked at a profit.

The success at Skouriotissa gives reason for hoping that further explorations may reveal the existence of other deposits of a similar character, but modern methods of prospecting will be required which would involve a large capital outlay and considerable risk. The efficacy of such methods and the mineral possibilities of some parts of the island would, in the opinion of the authors, justify further exploration on such lines.

United States.—An article by G. M. Schwartz on the hitherto little-known and rare mineral chalmersite ($CuFe_2S_3$) has appeared recently (*Econ. Geology*, 1923, **18**, 270). Chalmersite was originally described by Hussak, in 1906, as occurring in the gold mine of Morro Velho, Brazil, in the form of crystals associated with chalcopyrite and dolomite on limonite, derived from the alteration of pyrrhotite. Its occurrence on Prince William Sound, Alaska, was noted in 1913, where it exists as a massive mineral associated with chalcopyrite, arsenopyrite, pyrrhotite, blende, galena, gold and silver, in veins along sheared zones in greenstone. According to Bertrand L. Johnson (*Econ. Geology*, 1917, **12**, 519), it is found at eight widely-separated localities, and, at one of them, it has been mined, together with chalcopyrite, for several years. The mineral has recently been identified by Copeland in a polished specimen from the deposits at Parry Sound, Ontario. Besides chalmersite, there are pyrrhotite, chalcopyrite, magnetite and blende in a gangue of biotite and hornblende. In all these instances chalmersite occurs in veins which appear to be of the deep zone type.

The recent examination by Schwartz of polished surfaces of ores from Fierro in the Hanover district of New Mexico revealed the presence of chalmersite. The ores in the Hanover district are, in the main, of iron, with lesser deposits of copper and zinc. They are found in altered Carboniferous limestone close to its contact with a mass of quartz-diorite-porphyry. The ores are directly connected with diorite, and, according to Paige, are due to contact metamorphism. The principal workings are the Republic and Union mines, in which the ore carries much pyrite and chalcopyrite, and may contain up to 2 per cent. of copper. The ore minerals identified are, in order of abundance, magnetite, chalcopyrite, chalmersite, pyrrhotite, pyrite and blende. Magnetite is by far the most abundant mineral, and occurs as granular masses or isolated grains in the sulphide. Chalcopyrite is the most abundant

copper mineral, and forms considerable masses, which include the other minerals mentioned. Chalmersite occurs throughout the chalcopyrite, and is important from a commercial point of view. The iron cannot be separated by magnetic means from the copper, owing to the fact that chalmersite itself is strongly magnetic. Some other method of separating the copper, such as flotation, must therefore be applied.

Peru.—A general description of the copper deposits of the Ica department of Peru is given in the Imperial Institute Monograph, *Copper Ores* (1923, p. 201). According to A. B. Reader (*Eng. and Min. Journ.-Press*, March 31, 1923, p. 578), the Ica copper veins were known and were exploited on a small scale by the Incas and the Spanish *conquistadores*, but modern mining may be said to date from 1873. The three copper regions, known as San José de los Molinos, Canzas and Tingue, were worked by Narducci from 1873 to 1884, and in eight years he exported 24,000 tons of ore, averaging 25 per cent. of copper. From 1889 to 1902, and in four months in 1905, 389 tons of ore containing 27 per cent. of copper were exported from this region. Altogether forty copper veins have been partially developed and worked in the three districts of the Ica region. The width of the veins varies up to 8 ft., and the outcrops of some have been traced for 2,600 ft. Water level was reached in the Adelaide mine, in the Canzas district, at a depth of 660 ft. Rich sulphides occurred at that depth. Sulphides are also met with in the Peru mine, in the Tingue region, and in the Azurita (formerly Narducci) mine, in the San José de los Molinos district.

Gold

Union of South Africa.—The farm Batavia in the western Bushveld, near the Bechuanaland-Transvaal border, was proclaimed as a gold mining area in May 1923. The Batavia ore-bodies are of the banket variety (*South African Min. and Eng. Journ.*, April 28, 1923, p. 14). Two beds, about 400 ft. apart, striking E. by S., and W. by N., and dipping S. 32°, have so far been discovered. They each have a sandstone or quartzite roof and a shale or slate floor. The banket consists mainly of water-worn pebbles of vitreous quartz, from $\frac{1}{8}$ in. to over 6 in. in diameter, and some pebbles of felspar and quartz. The gold varies considerably in amount from point to point, and it is not known yet whether it is present in economic quantities. The banket occurs in the Ventersdorp system (*South African Min. and Eng. Journ.*, October 28, 1922, p. 152).

India.—The occurrence of gold in the Chota Nagpur Division of Bihar and Orissa is described by E. F. O. Murray (*Mining Mag.*, January 1923, p. 24).

The main features of the geology of the district that affect the occurrence of gold are: (1) the Dharwar Complex, mainly quartzites, slates and schists, with sills and laccolites of more or less metamorphosed greenstone; (2) gneiss, granite and granophyre; (3) doleritic intrusives of varying acidity. All these are of Archæan age. The auriferous deposits are confined to the slates, and consist of blue, grey and white quartz veins having small quantities of galena and chalcopyrite at higher elevations. Most of the gold hitherto obtained has come from a deposit situated near the southern edge of the Singhbhum granite-gneiss batholith (acid intrusive). The Porojarna mine, on the hill of the same name, was worked for some time. The formation is quartzite, schist and greenstone, with a general strike of N.-S., and an easterly dip. The veins are mainly lenses joined by narrower bands of quartz running parallel to the foliation. Some old workings existed here. In a cross cut put in from No 1 adit, four veins were cut, carrying 14 dwts., 7 dwts., a trace, and 28 dwts. of gold per ton over about a foot of quartz in each case, and a drive east on the fourth vein met with some very rich ground. The rich ore only occurred where the strata bent round E.-W. for 30 ft., and with a N. dip. The ore continued more or less rich to a depth of 55 ft., when the quartz died out altogether. On sinking, however, quartz came in again, but containing from 10 dwts. to 1 oz. per ton over an average width of 9 in. The main ore-body was struck in the lower No. 2 adit, 149 ft. from the portal. The quartz over a width of 3 ft. was worth 17 dwts. of gold per ton, but some cellular quartz on the hanging-wall, which showed numerous specks of gold in the cells from which the pyrite had been leached, assayed 42 oz. of gold to the ton. After cutting the vein in the eastern bend the No. 2 adit was turned west and advanced 80 ft., when the strata curved to the north to resume their original strike and the quartz died out. Another enrichment occurred on this flexure, the gold content increasing up to 3 oz. of gold per ton over 24 in., against an average of 43 dwts. over 32 in. for the whole 80 ft. Stoping between the No. 2 adit and the intermediate level opened a considerable ore-body, which had a maximum width of 18 ft., but gold contents were inclined to be patchy, and the average tenor of the ore did not exceed 12 dwts. per ton. As the workings became deeper, the value of the ore fell to 6 dwts. of gold per ton. Some of

the specimen rock encountered in the upper workings was extraordinarily rich, and two parcels weighing 56 and 66 lb. returned 128 and 140 oz. respectively (an average of 4·254 oz. to the short ton), but supplies of this ore were strictly limited. The mineralisation extended sometimes into the country rock, and a specimen of schist from the No. 1 adit winze contained numerous flakes of gold throughout, and some of the soft ferruginous schists just above this adit carried a gold content as high as 30 dwts. per ton. In many of the richer places some white quartz of more recent date than the grey and blue occurred, but it gave lower results and showed less visible gold than the latter. Small quantities of pyrite and copper minerals were found in some places, especially on the eastern bend, and these became more plentiful in depth. Of the 6,000 oz. of gold recovered, all but 250 oz. came from the Porojarna pocket (L. L. Fermor, *Records Geol. Survey India*, 53, Part 3, 1921, p. 269).

The lenticular nature of the veins seems to be typical of the deeper zone of the ore deposits, and though further prospecting may reveal other rich pockets, Murray is of opinion that the establishment of a gold-mining industry of any importance in these parts would appear to be somewhat remote.

Canada.—An account of some of the later developments in the Goudreau gold area (this BULLETIN, 1922, **20**, 541) is given by G. W. Macleod in *Canadian Min. Journ.*, April 20, 1923, p. 295.

The Michael property (4 claims) is near the north shore of Godin Lake in township 47. The gold occurs in quartz lenses in an extensive shear zone in a basic volcanic flow (Keewatin—pre-Cambrian), intruded by masses of quartz-porphyry, near which the best gold contents are found. The shear zone has an average width of 125 ft., and has been traced for 1,000 ft. Samples taken from all parts of the zone run from $0·60 to $19 per ton, the higher values being in the quartz lenses and the schist immediately associated with them. The largest of these enrichments has an average width of 7 ft., a length of 100 ft., and an average value of over $8·00 per ton. Besides iron and other carbonates, the schist and quartz contain pyrite, chalcopyrite and small amounts of galena. The gold is finely divided. The property is to be tested by diamond drilling.

On the property of the Goudreau Gold Mines, Ltd., the vein at the surface varies from 1 to 10 ft. in width, and free gold is visible in many places. Two shafts, 500 ft.

apart, have been sunk to the 200-foot level, and the vein has been driven on for 1,000 ft. Sinking is being continued to the 400-foot level.

Besides the above, there are many claims with promising discoveries, but on which insufficient work has been done to prove their value. There are two hydro-electric power plants already developed, one of which can furnish 2,500 h.p. and the other 30,000 additional h.p., if necessary. The present discoveries indicate the probability of another camp being added to the list of Northern Ontario's gold producers.

The Schreiber-Duck Lake area, on the north central shore of Lake Superior, Ontario, has been described by Percy E. Hopkins (*30th Annl. Rept., Ontario Dept. Mines*, 1921, Part IV, p. 1). Keewatin (pre-Cambrian) rocks occupy a considerable portion of the area. The main portion is basic pillow lava highly altered to hornblende, chlorite, carbonate, sericite and other schists. Interbedded with these are rocks of an intermediate or acid character. These rocks are intruded by large masses and dykes of granite, syenite and porphyry of Algoman age. The chief gold deposits of the area extend along the northern edge of this granite-syenite mass.

The McKellar-Longworth claim lies 2¾ miles south of Schreiber. A large east-west fault zone, traceable for over two miles, occurs here. At least three veins carrying visible gold have been found in this zone. On the east, one vein strikes E. 10° S., dips S. 55°, and varies in width from 1 to 5 ft., the wider parts comprising quartz and schist. The quartz is milky and bluish in colour, and contains considerable pyrite, with some chalcopyrite, malachite, pyrrhotite, galena and a little fine-grained arsenopyrite. There are some shallow workings on this vein, and the quartz in places averages $40 in gold per ton over a width of 18 in.

On the west is a vein in massive, red, porphyritic hornblende-syenite, averaging 8 in. in width, of milky quartz on the surface, carrying considerable coarse gold and tellurides, with some cobaltiferous arsenopyrite, chalcopyrite and pyrite.

Between these two veins is a series of parallel auriferous quartz veins, the whole being 12 ft. in width, and one wall being quartz-porphyry.

About one mile to the N.E., a shaft has been sunk 40 ft. on a vein lying between a mineralised quartz-porphyry and a dark hornblende-syenite. The vein is highly fractured, and contains a large percentage of chalcopyrite

and small quantities of molybdenite, galena and telluride in a quartz gangue. The ore is said to give favourable assays in gold and silver.

The gold-quartz deposits of the Lillooet Mining Division of British Columbia are described by W. S. McCann (*Memoir* 130, *Canada Dept. Mines, Geol. Survey*, 1922). Most of the mining properties in the district are still in the prospect stage, except at Cadwallader Creek, where there are a few well-established mines. The gold quartz deposits of the Cadwallader Creek belt occur as vein fillings in well-defined fissures in the augite-diorite stock (late Jurassic). There are two main systems of fissures, striking N.E. to S.W., and S.E. to N.W., respectively. The veins are characterised by frequent pinches and swells along their entire length. The richer veins display a banding or ribbon-structure due to subsequent movement along the plane of the veins and the sheeting of the quartz veins along what may have been lines of original sulphide deposition. The hydrothermal solutions have profoundly altered the wall-rock close to the fissures. The characteristic filling is quartz, usually milky white, calcite (subordinate), sericite, siderite, and dolomite in small amounts. Free-milling gold is found, associated with pyrite, arsenopyrite, chalcopyrite (rare), tellurium minerals (*e.g.* sylvanite), and stibnite. Galena, blende and tetrahedrite are present occasionally. By 1921 the vertical depth of the workings did not much exceed 300 ft. The Pioneer mine is said to average 13·5 dwts. of gold per ton, and the King vein of the Lorne mine is said to have yielded 17 dwts. per ton by amalgamation ; eight samples taken from the Woodchuck vein of the Lorne mine gave 3·4 dwts. of gold per ton, and four samples of the King vein 6·5 dwts. per ton. This mine is said to have produced gold to the value of $100,000. The total gold production of the Lillooet Mining Division from 1874 to 1918, inclusive, amounted in value to $1,968,500, but this includes a large quantity of alluvial gold.

Percy E. Hopkins has described the recent discoveries at Rouyn township, Quebec, 12 to 20 miles east of Opasatika Lake (*Min. Journ.*, June 2, 1923, p. 418). One quartz vein (the Powell) on the Noranda claims strikes N. 30° W. at or near a contact of altered mica-hornblende-granite and basalt. The vein averages 9 ft. in width for a length of 500 ft. Pyrite is finely disseminated through much of the quartz. The Horne deposit on Osisko Lake has a similar strike to the last, is 100 ft. wide in places, and has been traced for 1,000 ft. The deposit is a large body of

pyrite, pyrrhotite, arsenopyrite and chalcopyrite, carrying gold, and lying in a rhyolite-agglomerate zone near Keewatin basic lava.

Gold discoveries are stated to have been made in basalt at Pelletier Lake, and on the northern edge of the Temiskaming band of fragmental rocks on the Kinojevir River, in Joannes township. At Lake Fortune, discovered in 1906, basalt has been intruded by quartz-porphyry dykes; these have been replaced by dolomite, and intersected by veinlets of quartz and dolomite, carrying coarse gold and the telluride, petzite. A shaft has been sunk 130 ft., and a stamp-mill, etc., have been erected.

Iron

India.—The *Iron and Coal Trades Review* (April 13, 1923, p. 521) gives an account of the State Iron Works of Mysore, the distinguishing feature of which, as compared with other Indian iron-works, is the smelting of the iron ore by the use of charcoal.

The works are situated at Bhadravati on the Bhadra River, and are connected with the Bombay-Bangalore railway system by the metre-gauge Mysore Railway.

The iron ore is at present obtained 41 miles beyond Bhadravati, but the permanent source of supply is Kemmagundi, 25 miles south of Bhadravati. The quantity available is conservatively estimated at 4,000,000 tons, the average percentage composition of which is: iron, 60; silica, 2; alumina, 4; manganese, 0·12; sulphur, 0·042; and phosphorus, 0·045.

The product of the iron ore smelting is a pig iron of a superior grade suitable for foundry purposes and for high-grade castings.

Spain.—The iron-ore deposits of Bilbao, Almeria and Santander in Spain are fully described by R. W. van der Veen in *Economic Geology* (1922, **17**, 602).

The Bilbao deposits in the province of Vizcaya occupy the top and sides of an anticlinal fold in Cretaceous rocks. The primary ore is siderite, altered near the surface to a hard, red earthy hæmatite (*campanil*), to a soft, red earthy hæmatite (*vena*), or to a porous or cavernous limonite (*rubio*). The last, the commonest ore, is the result of removal and redeposition of the iron oxides in the upper part of the ore-bodies. Spathic ore (*carbonato*) also occurs.

Analyses of average ore of each kind are shown in the following table:

	Campanil. Per cent.	Vena. Per cent.	Rubio. Per cent.	Carbonato. Per cent.
Iron	52·70	56·80	51·0	38·0–41·0
Phosphorus	0·010	0·015	0·024	0·018
Sulphur	0·014	0·016	0·040	0·20
Manganese	1·03	0·65	0·37	0·7
Silica	5·3	6·2	9·7	6·5–6·9

The ore-bodies form irregular masses in the limestone, and are often of great size. Two of the most important lie in the Somorostro district at Trianon and Matamoros.

These masses vary in thickness from 33 to 130 ft., and are estimated to contain 160,000,000 tons of ore.

The ore-bodies and also a number of thermal springs are found at the intersection of two fault systems, approximately at right angles.

The ore region occupies an area about 18 miles long by 4 miles wide. The limit of the ore-bodies is not indicated by any sharp division except in the case of the "rubio" or redeposited ore.

The iron ore region of the province of Almeria comprises two ridges, the Sierra Alhamilla and Sierra de Filabres, which form the continuation of the main ridge of the Sierra Nevada on the east.

These ridges consist of crystalline schists on which rest remnants of the erosion of crystalline micaceous limestones, of possibly Archæan age. These are overlaid by strata of Triassic age. Both in the limestone and in the Triassic dolomite, iron ore deposits are distributed along fault fissures. Their structure resembles that of the replaced rock, but in other respects they are similar to the Bilbao ores. The primary ore here is also siderite, which has been largely altered to a hæmatite ore carrying about 50 per cent. of iron.

The iron ores of Santander province are considered to be of a residual type. They are found associated with residual clay on the eroded surface of dolomitic limestone of Cretaceous age. The ore consists mainly of a ferruginous chert of concretional or oolitic structure. The ore is separated from the clay by log washers, and deliveries have averaged between 55·66 and 60·70 per cent. of ferric oxide with low contents of silica, phosphorus and sulphur.

United States.—In *Eng. and Min. Journ.-Press*, April 21, 1923, D. P. Rohlfing describes the iron ore deposits of the Iron Springs district of Southern Utah. In 1856, and again in 1874, attempts were made to work the ore-bodies, but without success. So far, no systematic development has been undertaken, but the outcrops indicate an enormous tonnage of ore. Most of the outcrops occur at

elevations between 5,600 and 6,700 ft. on three isolated high points known as Three Peaks, Granite Mountain, and Iron Mountain. The rocks of the district are Carboniferous limestone, sandstone, shale, conglomerate, lava flows of trachyte, rhyolite, dacite and similar rocks, and quartz-monzonite which forms the core of the three hills referred to. The most important of these relative to the iron ore deposits are the monzonite, and Carboniferous limestone, the ore-bodies being found at or near the contact of these rocks, but in the limestone. The ore-bodies, where they are not obvious replacements, occupy former cavities, or consist of an iron-cemented breccia.

The ore is a mixture of magnetite and hæmatite, and on the average contains: iron, 58; manganese, 0·20; silica, 6·50; phosphorus, 0·20; sulphur, 0·05, and lime 4·0 per cent.

Lead

Australia.—According to the *Mining Magazine*, May 1923, p. 289, a strong lode of galena ore was discovered towards the end of 1922 about three miles N.W. of Zeehan, Tasmania. In opening up this lode early in 1923, seven others were exposed. Since then another promising lode is said to have been found to the west.

Two of the lodes have each a width of about 3 ft. of galena, but they have not been proved for any great distance. The lodes occur in a slate country, which is regarded as favourable for their continuance to a considerable depth.

Oil Shales

India.—The occurrence in the Amherst district of Burma of three basins of Tertiary rocks containing oil shales has recently been noted (*Rec. Geol. Survey, India*, 1922, **54**, Part I, p. 29). The basins are as follows: (1) the Htichara basin, lying between Thingannyinnaung and Tawok, about 14 by 9 miles in area, traversed by the Mepale River, and entirely in British territory; (2) the Phalu basin, extending to about 10 miles south of Myawaddi, and lying mostly in Siam; (3) the Mesauk-Mehtalaun-Melamat basin, lying mainly in Siam, but extending into Burma.

The oil shales occur in synclinal basins, the lower beds of which comprise sands, boulder beds, and conglomerates, and the upper beds mainly shales, amongst which occur the oil shales (*Rec. Geol. Survey India*, 1922, **54**, Part I, p. 55). Fossil shells collected in these deposits by G. de P. Cotter and J. W. Gregory prove the shales to be of

Pliocene age; they are therefore the youngest known oil-shales of importance. The basins lie in Triassic limestone.

The Htichara basin, which is the most accessible and on which most work has been done, has been described by Gregory (*Mining Journal*, Feb. 24, 1923, p. 145). A series of eight seams has been proved near the Mepale Kiou. At the base is a seam too thin to be of economic value under present conditions; the next above it, the outcrop seam east of Htichara, is the lowest of present commercial value. Numerous pits, trenches and bores show a gradual transition from rich shale to material of no immediate value. It is reasonable to suppose that shale may be workable at a profit at Htichara, under capable and economical management, if it occurs in seams of not less than 4 ft. in thickness, and contains not less than 8 per cent. of crude oil, or 22·4 gal. to the ton. The seams range in thickness from 4 to 16 ft. and the percentage of crude oil varies from 9 to 16. The oil is especially rich in lubricants, and its paraffin yield is also high, as is shown by the following percentages: light naphtha, 4; light burning oil, 13; heavy burning oil, 20; lubricating oil, 43; paraffin wax, 10; coke, 10.

The development of the field would require either a railway or motor road from the coast. The field is a little over fifty miles by road from Kyondo, whence an easy passage down the Gyaing River leads to the port of Moulmein. Gregory is of opinion that in the early days of the industry it may be most profitable to adopt somewhat quicker and cruder methods of shale treatment than are suitable to a mining field near the great markets and industrial centres of the Western world.

Canada.—The oil shales of New Brunswick are briefly described in the Imperial Institute Monograph, *Oil Shales* (1921, p. 31). Full particulars of those of the Albert mines and Baltimore areas, New Brunswick, are given by W. J. Wright in "Geology of the Moncton Map-Area" (*Memoir* 129, *Canada Dept. Mines, Geol. Survey*, 1922). The oil shale occurs near the base of the Albert series, which is the lowest known horizon of the Carboniferous system, and is correlated with the Calciferous Sandstone series containing the oil shale of Mid- and West-Lothian, Scotland. The Albert series may be divided into three zones: Zone No. 1, at the base, consists chiefly of coarse conglomerate grading upward into sandstone and shale, but poorly exposed in the Albert mines area. Zone No. 2 contains five beds of rich oil shale interbedded with low-grade and barren shale. Bed No. 1 (the highest of the

series) is chiefly "paper" shale, 50 ft. in thickness. Samples, taken in 1913, from about 5 ft. of the bed yielded 36 gal. of crude oil and 39·5 lb. of ammonium sulphate per long ton. Sample 29 of 2 ft. of poor-looking shale gave 12·7 gal., and Sample 31, of good paper shale, 23·8 gal. of crude oil per ton; 9 samples, representing 50 ft. of measures, which belong to bed No. 1, averaged about 13 gal. (extremes 5·6 and 21·3); 6 samples representing 45 ft. of measures, which appear to underlie bed No. 1, gave an average of about 20 gal. (extremes 17·1 and 22). Bed No. 2 is 4 ft. thick. A sample taken in 1913 yielded 43 gal. of crude oil and 57 lb. of ammonium sulphate per ton. Sample 32 of 4 ft. of platy shale, and sample 33 of rather massive shale yielded 17·3 and 16·7 gal. per ton respectively. Bed No. 3 consists of "curly" shale, 2½ ft. in thickness. A sample from the outcrops yielded 45 gal. of crude oil and 48 lb. of ammonium sulphate per ton. Four other samples taken here averaged about 16 gal. (extremes 11·3 and 28 gal.). Bed No. 4 of "curly" shale, is mostly 5½ ft. thick. A sample from the outcrop yielded 52 gal. of crude oil and 73 lb. of ammonium sulphate per ton. Another sample from the same locality gave 16·6 gal. per ton. Bed No. 5 (the lowest), of "curly" shale, is 3½ ft. thick. A sample from the open cut yielded 43 gal. of crude oil and 92 lb. of ammonium sulphate per long ton, whilst another sample from the same locality gave 26·5 gal. per ton.

The bulk of zone No. 3 is made up of barren micaceous shales with a few thin beds of oil shale of no economic importance.

Wright's conclusions regarding the deposits are as follows: (1) The area is underlain by shale, which varies from rich oil shale to barren shale and some sandstone. (2) Erosion has opened about 791 ft. of the measures, of which about 50 per cent. is exposed; the richest known beds form about 3 per cent. of the whole. (3) The workings of the albertite vein cut the shales where they are dipping about 75°, and penetrated only about 380 ft. of measures. It is doubtful if these workings reached bed No. 1. There is no available information to show the extent of the five known beds beneath the surface; hence any estimate of the total amount of oil shale is largely speculative.

The details of the oil shale in the Baltimore (Rosevale) area have not yet been worked out. Most of the beds (Albert series) are bituminous, but there are three zones, 30 to 50 ft. thick, richer than the others, that stand up as low ridges, which can be followed along the strike for at least 4,000 ft. Throughout the remaining two miles of

the belt there are beds of rich shale which are probably continuations of the zones mentioned above. At several points along the strike of each of the zones there is at least one very rich bed, from 3 to 7 ft. thick. No information is available as to the extent of the rich beds of oil shale.

According to W. S. McCann in an appendix to the abovementioned *Memoir*, the Ditrey Exploration Co., a subsidiary company of the Anglo-Persian Oil Co., has been carrying out exhaustive experiments on the oil shales of the Rosevale area. A small experimental plant has been built on the West Branch of Turtle Creek, with apparently satisfactory results. In one series of experiments (20 in all) an average of about 29½ gal. per ton was obtained from the Wallaa retort as compared with an average of about 28½ gal. from the Scotch tube method. The sulphate of ammonium, obtained in 10 experiments, varied from 7·84 to 13·90 lb. per ton, the average being 10½ lb.

Spain.—The oil shale industry, recently started by the (French) Société Minière et Métallurgique de Penarroya at Puertollano, province of Ciudad Real, Spain, is described by Etienne A. Ritter (*Eng. and Min. Journ.-Press*, Feb. 17, 1923, p. 326).

The oil shales are mined to a depth of 300 ft. in the Asdrubal coal mine, close to Puertollano. The chief bed is 6 ft. thick, and belongs to the Stephanian formation (Carboniferous). The shales contain over 30 gal. of oil per ton. The refinery covers 9 acres, and at the end of 1922 was producing 3,500 gal. of crude oil daily.

Petroleum

Borneo.—An article by A. H. Redfield on petroleum in Borneo has appeared recently (*Econ. Geology*, 1922, **17**, 314; cf. *Imperial Institute Monograph on Petroleum*, pp. 16, 56).

Besides the producing Miri oil-field of British Borneo, other possible oil-fields are the Belait district of North-Western Brunei, adjacent to the Miri field; the island of Labuan; the Klias Peninsula; and the valley of Sekuati River in British North Borneo. On Labuan Island a thick black oil seeps from a sandstone, 723 ft. thick, which is intercalated in shales. A bore-hole drilled 391 ft. into this formation encountered a high-pressure flow of gas, but no oil. At Kubong Bluff a shaft sunk 20 ft. in 1879 delivered about 12 gallons daily of petroleum of specific gravity 0·965. Petroleum seepages have been discovered in British North Borneo on River Sekuati. A shaft sunk to a depth of 35 ft. revealed, beneath 4 ft. of surface clay,

an oil-bearing ferruginous sandstone interbedded with shales. The petroleum is a thick oil or bitumen, containing a paraffin oil and an oxidisable substance of the terpene class. In the Belait district, Western Brunei, oil found in No. 2 well in 1914 at a depth of 1,820 ft. produced at the rate of 4 tons a day until June 1916, when it amounted to 1,500 gallons per day. The well was subsequently abandoned for want of storage.

The Koetei oil district, Dutch Borneo, includes the Sanga Sanga field in the Louise Concession, the Sambodja field in the Nonny concession, and the Moeara field in the concession of the same name. The oil horizons of Sanga Sanga and Sambodja are contained in the Sanga Sanga beds (Lower Miocene), which are composed of sandy clays, shales and impure limestones, 4,260 ft. thick. The Moeara beds (Upper Miocene) overlie the Sanga Sanga beds, and consist of light grey clays and sandstone, 2,640 ft. thick. This stage contains the oil of Moeara. There are several anticlines in the Koetei district.

The Tarakan district lies in the extreme north-east corner of Dutch Borneo, and includes principally the islands of Tarakan and Sebetik and portions of the immediately adjoining mainland. The Upper Tertiary in this district consists principally of light-coloured loose and poorly consolidated sands, alternating with well-bedded conglomerates, white to light yellow in colour. Thin coal seams occur here and there through the complex. Five anticlines, whose axes trend N.W., have been observed in the district. Tarakan Island was first developed in 1905. Commercial production began in 1907 with an output of 16,432 metric tons. The crude oils of Tarakan are of asphalt base, specific gravity 0·942 to 0·955, and are excellent liquid fuels.

The production of petroleum in Dutch Borneo from 1910 to 1920 inclusive amounted to 10,319,570 metric tons; of which amount, 6,781,531 metric tons were from Koetei, and 3,538,039 tons from Tarakan.

United States.—The Alaska oil-fields are described by H. C. George (*Eng. and Min. Journ.-Press*, December 30, 1922, p. 1163). From a geological point of view, there are two areas in Alaska which may prove of importance, viz. the Controller Bay region, including the Katalla and Yakataga districts, and the Alaska Peninsula area, which includes Iniskin Bay, Cold Bay, and possibly the Chignik districts.

The rocks of the Controller Bay region are interbedded shales, sandstones and conglomerates of Tertiary age.

In the Katalla district, owing to irregularity in dip and strike in the formation over short distances, no definite scheme of structure has yet been made out. In the Yakataga district the most pronounced structural feature is a long anticline showing numerous oil seepages along its crest. The oil from the seepages of this region is a transparent paraffin-base oil of a green or red colour, and of specific gravity ranging from 22° to 26° Baumé.

In the Alaska Peninsula area the rocks consist of shales, sandstones and conglomerates of Jurassic age. Two well-defined anticlines have been located in the Iniskin Bay district, as well as oil seepages. Three broad anticlines have been found in the Cold Bay area. The oil from the seepages of this region is paraffin-base oil of a brown or black colour, varying in specific gravity from 14·4° to 22·5° Baumé. Oil seepages have been reported from the neighbourhood of Chignik, 150 miles south-west of Cold Bay, and also from a point 300 miles south-west of the same bay.

Katalla is the only district in Alaska producing petroleum. The prospects for commercial production are good in all the districts referred to, and some large wells may be found in the Cold Bay district.

Sillimanite

In this BULLETIN (1923, **21**, 384) a short account was given of the nature, properties and uses of sillimanite, and reference was made to an occurrence of the mineral in the Khasia Hills of Assam. Further information regarding this deposit is given in *Rec. Geol. Surv. India* (1923, **55**, part 1, 26), from which it appears that Mr. F. W. Walker was deputed in 1922 by the Geological Survey to examine the deposits at Nongmaweit. He found that the material in question, which had been previously regarded as corundum, consisted of sillimanite, generally in massive form. Four outcrops, apparently in pegmatite, were found, but the chief source of the sillimanite at present consists of boulders.

Silver

Canada.—According to P. E. Hopkins (*Canadian Min. Journ.*, Feb. 9, 1923, p. 107), an important discovery of native silver was made on the Longworth claim, 1½ miles south of Schreiber, Ontario, in September 1922. The silver occurs in calcite, galena and quartz veinlets in a brecciated zone, 2 to 3 ft. wide, with two well-defined vertical fault walls striking N. 20° E. An open pit has exposed two small lenses of 100 oz. silver ore, 3 ft. long, 5 in. wide and 2 ft. deep. The largest piece of leaf silver

was about ½ in. in diameter. Pyrite, chalcopyrite, chalcocite, and probably argentite, are also present. The enclosing rock is an altered dolerite (" diabase "), which has lamprophyre and aplite phases.

The Silver Islet mine, in the Port Arthur district, Ontario, which, from 1869 to 1884, produced about 3,000,000 ounces of silver, was partially pumped out during the summer of 1920, for the purpose of sampling the roof and first level. Diamond drilling has been since in progress. The ore showing in the roof of the mine is largely macfarlanite with native silver, argentite, galena and blende. Macfarlanite proves to be an intimate mixture of silver, niccolite, smaltite, chloanthite, galena and blende, which is the typical association in the Cobalt area. The roof is 10 to 12 ft. in width, and consists largely of dolomite, rich in macfarlanite, blende and galena. The vein shows remarkable brecciation. It is estimated that several hundred thousand ounces of silver remain in the roof. In order to recover this without drowning out the mine, a ledge about 3 ft. wide has been cut in the wall so as to give a good passage-way the entire length of the workings. This will be roofed over with concrete, after which the roof will be blasted and the loose rock dredged from above (A. L. Parsons, *30th Annl. Rept.*, 1921, *Ontario Dept. Mines*, Pt. IV, p. 34).

References to the geology and ore deposits of the Salmon River District, Portland Canal Division, British Columbia, have already been given in this BULLETIN (1921, **19**, 106, 424). S. J. Schofield and G. Hanson have recently contributed a memoir on the subject (*Memoir* 132, *Canada Dept. Mines, Geol. Survey*, 1922). The ores are classified into three main groups : (1) a low-grade complex, siliceous type, with valuable contents of copper, lead and zinc; (2) a silver-gold type rich in gold and silver minerals (*e.g.* in the Premier mine) ; and (3) a pyritic siliceous type with high gold contents (an ore-body in the Premier mine). The most favourable geological conditions for the occurrence of ore in the area appear to be at the contact of the quartz-porphyry with the tuffs, in certain beds of the tuff and tuffaceous conglomerate, and in the quartz-porphyry sills. The slates in general appear to be unfavourable to mineralisation.

'The authors consider that the primary ore was deposited in late Jurassic time, and that the native silver, polybasite, pyrargyrite and some of the argentite at the Premier mine are probably secondary, whilst the sulphides rich in silver,

such as tetrahedrite, freibergite, most of the argentite, and some of the pyrargyrite are primary. They are also of opinion that the primary ore of the Dolly Varden mine, Alice Arm district (see this BULLETIN, 1922, 20, 389), is of the same age as that of the Premier mine, and that the pearceite, pyrargyrite, native silver and some of the argentite occurring in the ore are secondary.

The ore-bodies at the Premier mine occur at and near the contact of a quartz-porphyry sill and tuffs, both highly sheared and metamorphosed in the immediate vicinity of the ore-bodies. Both tuffs and sills are cut by a series of quartz-diorite dykes, striking N.W.

Schofield and Hanson deem it probable that at the Premier mine the gold will continue to greater depths than the silver. This appears to have been proved already in the deeper workings and by diamond drilling. According to a report, recently issued (*Min. Mag.*, May 1923, p. 321), an estimate of the assured and probable unbroken ore to the present bottom level (about 700 ft. vertical) is 300,000 tons, averaging 0·71 oz. of gold and 27 oz. of silver per ton. But below the No. 3 level (600 ft.) the average grade has dropped to 0·32 oz. of gold and 5 oz. of silver ; and six diamond-drill holes, cutting the ore-body to a depth of 100 ft. below the bottom level (*i.e.* to a vertical depth of 800 ft.), have shown a continuance of approximately the same milling grade of ore as that below No. 3 level.

Mexico.—The silver mines of Huantla, State of Morelos, Mexico, are described by R. B. Brinsmade (*Eng. and Min. Journ.-Press*, December 9, 1922, p. 1028).

The country rock—a greyish-green andesite—is traversed by many veins, few of which have proved of economic value. The principal or mother lode of the district, which strikes N.80°E. and dips S.70°, has been stoped at intervals for 2½ miles from the Tlalchichilpa mine on the west to the Peregrina mine on the east. At the western end, the altitude is 4,200 ft., and at the eastern end about 3,600 ft. The ore-shoots diminish in length and frequency from west to east. Much of the filling consists of angular fragments of andesite cemented by vein-quartz of a white, red or green colour. The ore-shoots occur at the intersection of cross fissures with the main vein. They vary in thickness from 3 to 10 ft., and in length from a few feet on the east end of the main lode and on the lesser veins to more than 300 ft. on the west end of the lode. The ore minerals follow veinlets within the vein, parallel to the walls. The chief minerals are bornite, tetrahedrite, magnetite, galena and argentite below, with their oxidised equivalents above.

The ores are rich in silver, often, by sorting, reaching 300 oz. per ton. The gold content is small, being usually 0·3 per cent. of the silver by weight. The richer ores are apparently due to secondary enrichment, but the primary sulphides appear to be of fair grade, for samples from the pay-streak of the San Francisco ore-shoot, which is about 1 ft. in thickness, assayed from 17 to 27 oz. of silver per ton and from 15 to 16·6 per cent. of lead.

The workings of the San Estevan and Pajaro Verde mines occupy a long ore-shoot on a parallel vein, dipping S.80°, situated about one-third of a mile north of the west end of the mother lode. The lowest workings are on the Pajaro Verde adit level, which is about 650 ft. below the outcrop, and about 1,000 ft. in length. The Santiago mine, half a mile from San Estevan on the same lode, has been stoped from surface to adit for a length of about 1,000 ft. The stopes average 5 ft. in width, and show a well-defined foot-wall but an irregular hanging-wall. This mine has been developed in one place to a depth of about 400 ft. below adit level.

Huantla is a very old mining camp, several of the mines having probably been worked by the Spaniards soon after the conquest, but, after water level had been reached, the district was practically abandoned for a long time. A revival took place about 40 years ago, when railroads had been built and heavy plant could therefore be transported to the mines. Four companies and the same number of mills were in operation here in 1895. From 1903 to 1910 the mines and mills were gradually closed down, largely owing to the revolution, and at present it appears that little or no development is taking place.

With regard to the possibilities of modern mining, the sulphide ores, which still remain below water level, contain so much lead and copper that they are unsuitable for cyanidation, and must therefore be concentrated, to free them from quartz, and smelted. Little smelting could be done locally, owing to scarcity of fuel and the lack of limestone and iron flux near the mines. Labour in Morelos is scarce and inefficient. Water power can be cheaply developed at the falls of the Rio Amacuzac, 15½ miles north-west of the camp.

Sodium Compounds

Union of South Africa.—*Memoir* No. 20, *Geol. Survey, Union of S. Africa,* is a monograph on the Pretoria salt-pan, by Dr. P. A. Wagner. The pan, which is situated about 25 miles N.N.W. of Pretoria, occupies a depression over 1,000 yards in diameter in the granite of the Bushveld,

encircled by a ridge whose sides slope steeply on the inside and gently on the outside. Originally, during the rainy season, the floor of the hollow was covered by a shallow sheet of strongly alkaline water, which evaporated during dry years, leaving the floor covered with crystalline common salt, thus constituting the most important salt-lick in the Transvaal, and a source of salt for human consumption. That the pan also contained valuable deposits of natural soda was discovered accidentally by a bore-hole put down by Dr. Hatch in 1896.

From geological evidence it appears that the pan is a sunken caldera, or bowl-shaped depression caused by subsidence connected with volcanic activity, distinct from an ordinary crater, and of similar origin to the Lonar Lake of India and the Crater Lake, Oregon, U.S.A. At the present time, the floor of the caldera is about 450 yards in diameter, the centre of which is permanently occupied by a dark pool of soda-salt brine by reason of the excavations which have been made of recent years. The surrounding area consists of soft, sticky mud of a dark greenish-brown colour ; the outermost ring is made up of granite detritus and boulders and this overlaps the " mud zone " considerably at the surface. The inner brine area is prevented from overflowing to any extent bv dams, but when this occurs the brine evaporates, depositing at first common salt and afterwards a reddish-coloured trona.

The central part of the floor, below the brine, is occupied by alternating layers of mud and trona, called the " trona-mud zone," but a considerable amount of this has been removed to provide calcined trona for neutralising mine waters on the Witwatersrand.

Numerous bores which have been sunk at various spots into the caldera floor disclose the fact that the mud is very much thicker around the edge than towards the centre of the caldera. The mud is interspersed with small glistening crystals of gaylussite (a double carbonate of lime and soda) and is strongly impregnated with sodium chloride, carbonate and bicarbonate, these being dissolved in the water with which the mud is saturated.

Below the mud zone there is the gravel or gaylussite layer, made up of discontinuous permeable layers mainly of large gaylussite crystals interbedded with impermeable layers of saline clay, the permeable layers being saturated with soda-salt liquor under sufficient pressure to enable it to be brought to the surface when a bore-hole strikes into it. The main supply of liquor is derived from the outer portion of this layer, and the liquid, which is of champagne colour, consists essentially of an aqueous solution of sodium

chloride (NaCl), carbonate (Na_2CO_3) and bicarbonate ($NaHCO_3$) giving on analysis in a typical instance, NaCl 17·29 per cent.; Na_2CO_3 8·47 per cent.; $NaHCO_3$ 1·4 per cent.

The author enters into a detailed discussion of the probable mode of origin of all these layers and concludes with an account of their economic possibilities. Numerous attempts have been made from time to time to exploit the salts in the caldera commercially, but until 1911 these aimed solely at producing common salt and were soon abandoned. Attention was next paid to the trona layers, but as the excavations became deeper complications arose which caused work to cease in 1916. The following year an attempt was made to work the soda-rich mud, but this also failed. An elaborate plant was next erected to treat the soda-salt brine, but this again was unsuccessful. Then a boring compaign was resorted to and the gaylussite layer discovered with its enclosed liquor. It was found that by suitably cooling this, the soda could be obtained as almost pure decahydrate. The plant was modified and produced about 3 tons of calcined soda per day, but this did not prove profitable. Eventually, a most ingenious process was devised by means of which all the salt and all the soda could be recovered. If the requisite additional capital is forthcoming there seems a good prospect of success attending this last project.

Tin

Federated Malay States.—The recent examination of a portion of the Ampang Salak field for dredging purposes is described by J. B. Newsom (*Eng. and Min. Journ.-Press*, March 17, 1923, p. 485; March 24, p. 529).

The Ampang Salak field, State of Selangor, is about 4 miles east of Kuala Lumpur, and covers about 14,000 acres, most of which is dredgeable. The particular tin-bearing lands examined cover some 4,000 acres. From 12 to 15 drill crews were employed, and more than 3,500 bore-holes were sunk to bedrock. The depth to bedrock varies from 10 to 100 ft., with an average of 35 ft. The field is practically flat and is surrounded by a range of hills about 500 ft. high. The bedrock of the valley is limestone, much pitted and dissolved along fracture and bedding planes. The rim is granite. In the south-eastern part of the area the granite hills give place to schist, the limestone dipping under the schist hills. The cassiterite varies from angular lumps, weighing about a pound, to fine sands which will pass through a 200-mesh screen. At

the margin of the field the cassiterite is largely residual or angular. Towards the centre, layers of rounded alluvial cassiterite are found. Much of the area is swampy. The ground generally consists of black mud to a depth of about 4 ft., below which are clay and sand.

The preliminary boring was done on a staggered pattern, putting holes at 400-ft. intervals on lines 200 ft. apart. In re-examined parts intermediate holes were put in, so as to finish the pattern with holes in 200-ft. squares on E.-W. and N.-S. lines.

Hand-drills of the Banka type were adopted, being good for depths of 100 ft. or less. The drill was operated by a crew of eight men. The average depth per hole per day was 25 ft. in swamp and 30 ft. in ordinary clay and sand, and the cost (1920) was \$0·39 and \$0·32 per foot, respectively. Full details are given in the article as regards other costs, methods of surveying, plotting, mapping, drilling, sampling and washing employed, but the actual results of the sampling are not stated.

United States.—E. Steidtmann and S. H. Cathcart have written a full description of the geology of the York tin deposits, Alaska (*Bull.* 733, *U.S. Geol. Survey*, 1922). The cassiterite-wolframite-bearing quartz-porphyry dykes, intrusive in granite, of the Lost River area were developed during the season of 1918, the results giving an estimate of 107,500 tons of tin-bearing dyke rock as probably available above the level of Cassiterite Creek. Mill tests of the dump material from the adits show an average of 4 per cent. of concentrate, containing 62·33 per cent. of tin and 11·09 per cent. of tungsten.

About two-thirds of the tin production of the United States has hitherto come from the Potato Mountain area of Alaska, where, thus far, the Buck Creek placer deposits have been the chief source of ore. From 1911 to 1919, inclusive, 1,194 short tons of placer-tin concentrate were produced on Buck Reef. The worked placers have shown an average yield of about 8 lb. of concentrate, averaging 68 per cent. of tin, to the cubic yd. Some gold occurs in the concentrate. The bed-rock is slate, and the average depth of gravel is 5 ft. The Buck Reef placers seem to be about two-thirds exhausted. Most of the streams N.W. of Potato Mountain are reported to show tin, and deserve exploration.

No deposit of lode tin in commercial quantity has yet been discovered at Cape Mountain, Ear Mountain, Back Creek or Brooks Mountain.

Tungsten

India.—The northern extension of the wolfram-bearing zone in Burma has been described by J. Coggin Brown and A. M. Heron (*Rec. Geol. Survey, India*, 1922, **54**, 235).

Yengan State, the most northerly of the Southern Shan States, has an area of 400 square miles. Five prospecting licences for tungsten covering a total area of 8,000 acres had been granted in the State by the end of 1918, and the following information concerning one of them is based on reports made by the geologist of Steel Bros. & Co., Ltd. The concession is about sixteen miles due east of Thedaw railway station. In it are two main granite exposures separated by altered sedimentary rocks, mainly clay-slates and quartzites. Numerous quartz veins, from a few inches to 3 ft. in thickness, traverse the rocks with a strike varying from a few degrees north of E. to N.E., the dip being northerly and generally steep. The thinner veins often die out a short distance along their strike and are replaced by parallel veins *en échelon.* Close to the granite they contain wolfram both in the granite and in the sedimentary rocks, but farther away they become barren. The veins are said to be most productive when they occur in fissures at right angles to the major axis of the intrusion. The mineralisation is irregular and patchy and greisenisation is common where the veins traverse the granite. Molybdenite is associated with wolframite in one place. Oxidised compounds of copper and iron are found in the upper portions of the veins, and appear to indicate the presence of sulphides below the zone of decomposition.

There were small outputs of wolframite from the Mawnday State in 1917 and 1918 and from the Kyauske district in 1919.

NOTICES OF RECENT LITERATURE

THE POCKET GUIDE TO THE WEST INDIES, BRITISH GUIANA, BRITISH HONDURAS, THE BERMUDAS, THE SPANISH MAIN AND THE PANAMA CANAL. By Algernon Aspinall, C.M.G. New and Revised Edition. Pp. x + 479, 8vo, 7 × 4½. (London: Sifton, Praed & Co., Ltd., 1923.) Price 10*s*.

The previous edition (1914) of this indispensable guide, which contains the best available general account of the British West Indies, was reviewed in this BULLETIN (1914, **12**, 641). The past ten years have witnessed events of great commercial and political importance in the Caribbean area, the most notable being the opening of the Panama Canal in 1914 and the transference in 1916 of the Danish possessions of St. Thomas, St. Croix and St. John to America under the name of the Virgin Islands of the United States. The outstanding event in the British West Indies has been the visit of H.R.H. the Prince of Wales in 1920, while the more recent official tour of the Right Hon. Edward Wood, M.P., as Parliamentary Under-Secretary of State, has directed public attention to the present condition and possibilities of these interesting and important countries of the Empire. A new edition of the guide therefore seemed appropriate and the present volume has been entirely rewritten to bring the information up to date. The subject-matter is essentially the same as in the last issue and includes descriptive accounts of the foreign possessions in the West Indies. The sections, however, have been advantageously rearranged and an entirely new set of maps, specially prepared for the volume, has been included, adding still further to the utility of the book.

BERMUDA: PAST AND PRESENT. By Walter Brownell Hayward. Pp. xii + 242, 8vo, 7½ × 5. (London: Stanley Paul & Co.) Price 8*s*. 6*d*.

The book is designed as a guide for visitors to Bermuda. Six early chapters are devoted to the history and development of the Colony up to the close of the Civil War in America (1861–5), while a few pages at the end of the book relate the part played by the islanders during the late war (1914–18). Special emphasis is laid upon the historical relationship between Bermuda and the United States.

Other chapters are given to detailed description of Bermuda by parishes, to literary associations, recreations,

resources, and method of Government. The book closes with a few facts that may prove useful to visitors and with a list of hotels and boarding houses. The map is clear and good.

The book is most open to criticism in the chapter on the origin of the islands, etc. The author does not appear to be clear on the distinction between corals and molluscs. It is, of course, to the former as well as to hydrocorallines and calcareous algæ that reefs are due. The reader is further left to imagine the part played by comminuted corals, foraminifera, etc., in the building of the Æolian limestones. Confusion is also shown between the terms " barrier reef " and " coral atoll."

It is unfortunate that in describing the fauna and flora the author has omitted to append scientific names. This renders the book practically useless as a record of native plants and animals. To most readers, such expressions as " black rods " and " bulky sea puddings " among the fauna, or the " life-plant . . . laden with floppers " among the flora, would be meaningless.

With the exception of these blemishes the book is full of interest and picturesque detail, and should be read by every intending visitor to Bermuda.

BURMA. By Sir Herbert Thirkell White, K.C.I.E., late of the Bengal Civil Service. Pp. x + 226, 8vo, 8 × 5½. (Cambridge: The University Press, 1923.) Price 8*s.* 6*d.*

This is an addition to the " Provincial Geographies of India," a useful series of small books which is being issued under the general editorship of Sir Thomas Holland. Interrupted during the war, the publication of the series has again been resumed with this volume. The author has had a long and intimate acquaintance with Burma as a civil servant, and his knowledge of the country and its inhabitants has therefore been acquired at first hand, and in the limited space at his disposal he has given in a concise form a large amount of information about the country and people of Burma. The text is divided into twenty chapters and deals not only with a description of the physical features of the country but also with the administration, the geology, fauna and flora, the life and occupations of the people, their arts and crafts, and the trade and commerce of the country. The book is well printed and contains over eighty reproductions of photographs, together with two sketch maps. Appended to the volume is a bibliography of official publications and general literature relating to Burma, and statements

relating to rainfall, administration and trade. A glossary of Burmese names and an index are also supplied.

To the general reader interested in Burma as well as to the student of geography the book should prove very useful.

PATROLLING IN PAPUA. By W. R. Humphries, A.R.M., with an Introduction by J. H. P. Murray, Lieutenant-Governor and Chief Judicial Officer of Papua. Pp. 287, 8vo, 9 × 5¾. (London: T. Fisher Unwin, Ltd., 1923.) Price 21s.

The author has dedicated this book to the "Outside Men of Papua," the designation by which are known the magistrates and patrol officers whose duties are performed in the least civilised and remotest parts of the island.

The patrols here described were carried out at intervals during the years 1917–19 with the object of linking up the scattered Government outposts in the Gulf, Central, Mambare and Kumusi Divisions of the Territory, the most important being that from Nepa to Karema on the Gulf of Papua, and Nepa to Moroba on the Huon Gulf in the late German New Guinea, with a view to discovering a cross-island route from east to west.

In his preface the author confesses that "the book has no scientific value" but hopes that it may be of interest to the "man in the street." The work should certainly attain this end with those members of the public who care for books of this type.

Perhaps the chief fault of the book lies in the lack of a good map. That provided is too small. Two maps, one general and the other particular, as in the *Annual Report of Papua*, 1917–18, would have been more serviceable.

The book gives a very vivid account of the difficulties besetting explorers in the little-known interior of the island. The greatest difficulty is that of transport. The country is generally scantily populated, although Mr. Humphries found that beyond the Chapman Range in New Guinea where the Kwolum and Waria Valleys contain extensive areas of grass land, the population is comparatively dense.

For this reason opportunities of obtaining supplies, save from chance sago palms and native gardens on inter-tribal routes, are few and far between, and everything must be carried on men's backs. The country is unsuited for animal transport. The natives are unfortunately averse from acting as carriers, if not actually hostile.

The greater part of the book is devoted to the accom-

plishment of the Cross Island Patrol. Mr. Humphries is to be congratulated on the boldness with which he overcame the transport problem and on his tactful and careful leadership by which he brought his party to their goal without loss of life.

Mr. Humphries does no more than hint at economic questions. The Lakekamu goldfields at the time of writing were almost a thing of the past. Of other minerals a discovery of coal (?) is mentioned on the east side of the Chapman Range, but the specimens were unfortunately lost on the way to Morobe. Of agricultural crops, exceptionally fine sugar cane is recorded in the Movwi valley in New Guinea and extensive areas under tobacco. So far as labour is concerned, in New Guinea militant methods of recruiting have antagonised the natives, while of the two Papuan recruiting grounds, Kumusi and Mekeo, the natives of the former will, in Mr. Humphries's opinion, become more amenable when pre-war conditions are fully restored, while those of the latter " simply hate hard work " and only cultivate, save under Government compulsion, sufficient ground for their own needs. Mr. Humphries considers that only the march of civilisation will bring about the full economic development of this " unhealthy but most fertile district." Labour supply and transport facilities are the key to the development of Papua.

The Beginnings of Agriculture in America. By Lyman Carrier, B.S., M.Agr., Agronomist, United States Bureau of Plant Industry. Pp. xvii + 323, 8vo, 9½ × 6¼. (London: McGraw-Hill Publishing Co., Ltd., 1923.) Price 15*s*.

In his preface to this work Mr. Carrier says that " an adequate history of agriculture in the United States has yet to be written, and when it is, it must, to be reliable, be based on a thorough understanding of farming achievements of the colonists." He intends the book to be a supplement to " the many excellent colonial histories now available," and therefore takes for granted in the reader a knowledge of the main facts of importance in the early history of America.

It may safely be said that in this interesting and informative volume Mr. Carrier has gone far towards supplying any want there may be in the direction indicated. He has furnished sufficient material to give his readers a clear conception of the lines on which the early colonial agriculture of America developed, and of the manner in which the various nationalities concerned (principally English, French, Spanish and Dutch) took their share in

the work; he also shows the extent to which progress was based on native Indian agriculture, which had in certain localities attained a high state of development before the country was colonised at all.

The book commences with a dissertation on agricultural history as such, and its relation to biological and social evolution, and then proceeds to describe the natural flora of eastern America, the crops grown by the Indians, and the manner in which the cultivation of these products was taken up by the early colonists and in many cases introduced by white enterprise into other parts of the world. Following this is a carefully arranged account of the early settlements and their agricultural development, with separate sections for each of the eastern states, whilst the author also describes the way in which European crops were introduced to supplement the native products. Later chapters deal with the introduction of domestic animals from abroad, farm implements and fertilisers, the economic aspects of slavery, and the effect of colonial commerce on agriculture.

Not only the agriculturist, but also the general reader, will find Mr. Carrier's treatise well worth perusal. The interest of the volume is enhanced by an excellent bibliography and by a number of illustrations of considerable historical value, and the work can be recommended as a clear and most instructive presentation of the subject with which it deals.

A Smaller Commercial Geography. By George G. Chisholm, M.A., B.Sc. (Edin.) and J. Hamilton Birrell, M.A., F.R.S.G.S. Pp. xiv + 302, 8vo, 7½ × 5. (London: Longmans, Green & Co., 1923.) Price 5*s*.

This is a new edition of a work first issued in 1890, as an abridgment of Mr. Chisholm's *Handbook of Commercial Geography*, the last edition of which was recently reviewed in this Bulletin (1922, **20**, 416). The general arrangement is therefore on similar lines. The work is free from certain of the inaccuracies mentioned in the review of the larger volume and commendation is due to many of its features, but it unfortunately shows numerous defects, some of which are mentioned below.

As regards certain parts of the world, and notably tropical Africa, there is considerable lack of precision in geographical and political matters. Thus, on p. 178 it is nowhere stated that Kenya and Uganda are under British rule, and on the next page the islands of Zanzibar and Pemba are erroneously alleged to form "the Kenya Protectorate." The descriptions of Nigeria as "under British

rule or influence" and of Tanganyika Territory as "now under British influence" do not tell the reader that these two countries are definitely and completely under British administration (in the second case as a territory mandated by the League of Nations); and similar looseness of wording is evident on p. 177, where the Portuguese are stated to "exercise authority" in part of East Africa for "a certain distance inland," from which the reader would imagine that the extent of their rule was undefined, whereas the boundaries of Portuguese East Africa are quite definite. On p. 143 the relation of the Federated Malay States to British authority is very vaguely and inadequately described, whilst the statement on p. 125 that Cyprus is "recognised" as a British Protectorate, though true in former times, does not make clear the present status of the island.

Another section calling for comment is that dealing with commodities (pp. 14 *et seq.*) which contains a number of misleading and loosely worded statements that should have been avoided in a work of this nature. On page 19 the reference to cotton as growing "in large tufts surrounding the seed of a bush" is more likely to mislead than to instruct. The paragraph on p. 22 regarding tropical vegetable fibres contains several questionable statements, and opens with some obscurely worded phrases liable to give the reader the impression that jute is used for making plush and velvet. The statement on p. 23 that gums resemble resins except as regards solubility in water is inaccurate. On p. 28 the terms "paraffin oil" and "paraffin" are applied exclusively to products of Scottish oil shales, and this error is immediately followed by another, viz. the limitation of the term "kerosene" to oil from New South Wales.

These blemishes are the more regrettable since the work is in many respects admirably arranged, and if properly revised would form one of the best and handiest compendiums of commercial geography available.

THE SOY BEAN. By Charles V. Piper, M.S., D.S., Agrostologist, United States Department of Agriculture, and William J. Morse, B.S.A., Agronomist, United States Department of Agriculture. Pp. xv + 329, 8vo, 9 × 6. (London: McGraw-Hill Publishing Co., Ltd., 1923.) Price 30*s*.

Although now well known as an article of commerce in Europe and America the soy bean is not cultivated to any large extent outside Manchuria, China and Japan, in which countries it had long been in cultivation before

it became known in Europe and the United States. The introduction of the soy bean into European commerce on a large scale is said to have been brought about chiefly as a result of the Russo-Japanese War of 1904, when, on the termination of hostilities, it became necessary to find new markets for the surplus beans which had been grown in Manchuria in increased quantities for local use. Trial shipments were sent to England in 1908 and the suitability of the seed for oil and oil-cake having been recognised the trade soon extended to other European countries and to the United States, and now appears to have become firmly established. In addition to the beans, the expressed oil and cake are also largely exported from Manchuria and in this book it is suggested that the tank steamer, carrying bean oil as a return cargo, would solve the problem of a suitable method of transport for the oil. Although the soy-bean crop is still largely confined to countries of the Far East there are possibilities that in the future it will be an important crop in the United States, where it has been found especially suitable as a rotation crop in the corn belt. It is estimated that in 1920 there was an area of 950,000 acres under soy beans in the United States, of which 190,000 acres were harvested for seed, the balance being utilised for pasturage, forage and ensilage.

It is in view of future possibilities that the available information regarding the soy bean, likely to be of use to students, farmers and manufacturers in the United States, has been brought together in the present volume. The advantage of having the gist of the scattered information in one book is evident when it is stated that a complete bibliography of the subject contains more than 1,200 titles.

The book opens with a brief sketch of the botanical, commercial and agricultural history of the soy bean, followed by chapters on the cultivation and harvesting of the soy bean crop. Although written with a view to climatic and other conditions obtaining in the United States, the cultural information has a wider application and should prove useful to growers in other countries. The soy bean is particularly adapted to temperate regions having warm humid summers, such as, in the United States, are suitable for corn (maize) and cotton. Under tropical, and even sub-tropical, conditions it is said that seeds fail to develop even if the plants thrive, and in such countries it can only be expected to succeed at high altitudes. The chief soil requirement appears to be the presence of suitable nodule-producing bacteria which enable the plants, in common with other leguminous species, to utilise the nitrogen of the air. Where suitable

bacteria are not already in the soil, artificial inoculation by means of special cultures or by utilising soil from areas where the soy bean has been successfully grown, is advocated, especially on soils poor in nitrogen.

Later chapters which deal with the composition and the utilisation of the soy bean give much useful information, especially as regards the factors which influence the oil content of the seeds, and the numerous uses of the soy bean plants as green manure, forage and pasture, and the utilisation of the seeds as a source of oil and as a foodstuff for man and animals.

The cultivated varieties of the soy bean are numerous and upwards of 800 have been tested by the United States Department of Agriculture, but only about twenty varieties are in general use in the United States. A classification, with description of the more important varieties, is given, together with some account of hybridisation and breeding experiments.

The microscopic structure of the seed is described and illustrated, and it is pointed out that the presence of the peculiar "hourglass" cells furnishes one means of readily identifying soy-bean meal.

Soy-bean oil and soy-bean cake or meal are dealt with, and their uses in manufactures and as food for animals are discussed. A special chapter is devoted to soy-bean products for human food, and investigations in the United States have shown that, with the possible exception of flax and millet, soy beans are the only seeds, so far examined, that contain both the water-soluble and fat-soluble vitamines in sufficient amounts for the promotion of proper growth. The numerous food-products prepared from soy beans in Asiatic countries are described, and domestic recipes are given which should result in an extended use of this valuable food-product elsewhere. The concluding chapter treats of the enemies of the soy-bean crop in the United States, there being no available data regarding the pests of the crop in Manchuria and China. An extensive bibliography and a full index are provided. It will be gathered from the foregoing that this book has a wide scope which should make it of great value to all interested in the soy bean, whether from the point of view of the cultivator or of the manufacturer of soy-bean products.

INDIAN TEA: ITS CULTURE AND MANUFACTURE. By Claud Bald, 4th Edition. Pp. 397, 8vo, $8\frac{3}{4} \times 5\frac{3}{4}$. (Calcutta: Thacker, Spink & Co., 1922.) Price Rs.12.

In a notice of the third edition of this textbook which appeared in this BULLETIN (1917, **15**, 459), the work was

recommended to anyone who desired to obtain authoritative information on the industry, and comment was made on the fact that, notwithstanding the importance of the tea industry there were few reliable textbooks on the subject. That a demand for such a book exists is evidenced by the appearance of this fourth edition which differs little from its predecessor, but has received certain additions which research and the changes in the practice of tea cultivation and manufacture have rendered necessary. The principal additions have been made to the chapters on draining and manuring, two very important subjects in tea cultivation; and to the parts treating of cooly lines and sanitation. Other chapters in the book have received slight alterations and additions, such as, for instance, the chapter on green-tea manufacture, and the chapter on machinery. In the former, paragraphs dealing with glazing, steaming and rolling have been added, whilst in the latter the paragraph relating to the objection to oil engines has been deleted, and a note inserted to the effect that oil engines are coming into favour and that the boilers of steam engines are being adapted to take oil fuel in places where coal is scarce or expensive.

As in the case of the previous editions, this book should prove of value to those desiring practical information on the subject with which it deals.

THE DESTRUCTIVE DISTILLATION OF WOOD. By H. M. Bunbury, M.Sc. (Bris.), B.Sc. (Lond.). Pp. xx + 320, 8vo, 9½ × 7½. (London: Benn Brothers, Ltd., 1923.) Price 35*s*.

In view of the continually increasing importance of the destructive distillation of wood to industrial and economic expansion, the publication of a complete monograph on the subject in the English language will meet a long-felt need.

The work gives an account of the rise, development and present position of the wood-distillation industry, describes the varieties of wood employed, discusses their physical properties and chemical composition, and deals fully with the commercial products resulting from their thermal decomposition.

The different branches of the industry, including hardwood distillation, soft-wood distillation and distillation with steam, are considered, and information is supplied regarding the construction and equipment of the factory. A full description is given of the plant and operations involved in the production of charcoal, crude pyroligneous acid, calcium acetate, wood spirit, pure methyl alcohol,

wood turpentine and pine oils, wood tar, wood oils and wood pitch. A special chapter is devoted to the destructive distillation of small wood and wood waste (including sawdust, nut shells, etc.), and another to the production of illuminating gas and power gas from wood.

Methods of analysis of the various crude and refined products of wood distillation are described, and statistics of production, imports, exports, etc., are recorded for European countries, the United States and Canada.

The book contains a detailed and well-illustrated description of the plant, processes and methods adopted in modern practice, and elucidates as far as possible the complicated reactions which accompany thermal decomposition. It has been carefully compiled and clearly written and will doubtless be of considerable service to chemists, technologists and others interested in destructive wood distillation and its products and in the utilisation of waste wood.

SYNTHETIC RESINS AND THEIR PLASTICS. By Carleton Ellis. Pp. 514, 8vo, 9¼ × 6¼. (New York: The Chemical Catalog Company, Inc., 1923.) Price $6.00.

It is only within recent years that this interesting field of chemical research has found industrial application, synthetic resins having been slow to find general adoption in this country in spite of the fact that their value in varnish-making and for other purposes has been definitely established. During the last few years a very large number of patents have been granted in connection with the manufacture of synthetic resins, and an extensive though scattered literature has been published on the subject. This information has been collected together in the present volume, which has been written especially for the chemical investigator.

The work includes extensive data on little-known resinous substances, the commercial possibilities of which have hitherto been overlooked. It also contains an account of the author's own researches and much other information on the subject of resinous materials.

In the introduction, synthetic resins are divided into two broad groups: (1) resins formed by reacting on non-resinous substances with a resinifying agent, and (2) resins made by reacting on natural resins with chemical agents.

In the first chapter is discussed in an interesting and practical manner the need for synthetic resins and the types desired. Three chapters are devoted to cumaron resins, modern methods of production, commercial grades, and their uses and identification. Resins obtained from

other unsaturated hydrocarbons, particularly those of petroleum, are also described. The important group of synthetic resins obtained by the condensation of phenols and aldehydes is dealt with in four chapters, and includes the commercial products—Bakelite, Condensite and Redmanol—and the various applications of phenol-formaldehyde resins.

Other chapters deal with furfural resins, ketone resins, urea and thiourea resins, resins from wood distillation products, hardened rosin and resinates, "ester gums" or artificial resin esters, resins from polybasic acids and polyhydric alcohols, polymerisation of ethylene derivatives, sulphur and nitro-resins, chlorinated rubber compounds, miscellaneous resins, resinous products derived from fatty oils, and the preparation and properties of plastic moulding compositions.

The last three chapters afford information as to equipment for moulding plastic compositions, methods of moulding, and tests of quality of moulded articles. The value of the book is enhanced by eighty-eight figures chiefly of apparatus for moulding resins.

FORMULARY OF THE PARISIAN PERFUMER. By R.-M. Gattefossé. Third English Edition. Pp. 85, 8vo, 7¾ × 5¼. (Villeurbanne, Rhône: *La Parfumerie Moderne*, 1923.) Price 4*s*.

This book by a well-known French authority on essential oils, and editor of *La Parfumerie Moderne*, is a translation of the fourth French edition which has attained a large circulation, and is regarded as the *vade mecum* of the French perfumer. It describes very briefly, in the first place, the formation, extraction, classification, rectification, testing, etc., of essential oils. Synthetic perfumes, their classification, and the composition of the principal non-alcoholic perfumes of which they form ingredients are next dealt with, and a concise and practical account is given of fixatives, mention being made of those best suited to each perfume. The book closes with recipes for a number of perfumes and toilet preparations.

DIZIONARIO DI MERCEOLOGIA E DI CHIMICA APPLICATA. By Prof. Dr. G. Vittorio Villavecchia in collaboration with Professors Dr. G. Fabris, Dr. G. Rossi, Dr. A. Bianchi and Dr. R. Belasio. 4th Edition. Volume I, Abelmoscho—Cuscuta. Pp. xvi + 438, 8vo, 10 × 7. (Milan: Ulrico Hoepli, 1923.) Price L. 35.

This encyclopædia has been completely revised, corrected and enlarged, and the first of the four volumes of the new edition has just appeared.

The work deals with the raw materials of the chemical, pharmaceutical, metallurgical and agricultural industries, and also with foodstuffs, dyes, textiles, fuels, distillation products, sugars, oils and fats, essential oils, tanning materials and many other products. Statistics of production, exports and imports are provided together with information relating to fiscal matters and transport.

Each article gives the commercial or technical name of the product (in Italian) with which it deals, followed by Italian synonyms and the French, English, German and Spanish equivalents. The chemical formula is added in the case of substances of known constitution and the botanical or zoological name in the case of plant or animal products. An account is given of the characters, properties and composition of the substance and the methods of preparing or extracting it and of determining its quality and purity, together with information on packing, exportation and marketing.

The articles have been carefully written and the encyclopædia will form a useful work of reference for the chemist, pharmacist, manufacturer, agriculturist and scientific workers generally, as well as for exporters, importers, merchants and manufacturers and others interested in the raw materials of industry and commerce.

THE CHEMICAL EXAMINATION OF WATER, SEWAGE, FOODS AND OTHER SUBSTANCES. By J. E. Purvis, M.A., and T. R. Hodgson, M.A. Second and Enlarged Edition. Pp. iv + 346, 8vo, 8¾ × 5¾. (Cambridge : The University Press, 1922.) Price *20s.*

This work, issued in the "Cambridge Public Health Series," was prepared as a textbook for students attending courses of instruction for diplomas and degrees in Public Health and for those engaged in the study of water, sewage, sewage effluents, foods, disinfectants and other products. Methods of analysis are described which have been tested and used by the authors, but many well-known methods have been omitted.

The new edition contains a considerable amount of additional information and some more recent analytical methods. The chapters on water and milk have been extended, and a more detailed account is given of the analysis of foods and beverages. There is still room for improvement, however, in the section dealing with foods, the information in some cases being very meagre. A short chapter has been added on toxicological analysis.

The book contains a short bibliography of standard

works on the various subjects dealt with, and a useful index.

A TESTED METHOD OF LABORATORY ORGANISATION. By Seymour Pile, M.A., and Reginald G. Johnston. Pp. xx + 98, 8vo, 7½ × 5. (London: H. F. & G. Witherby, 1923.) Price 7*s.* 6*d.*

This book is stated to be largely the result of experience gained in organising and conducting on co-operative lines a laboratory for physical and chemical testing which was started to meet the needs of a group of alloy manufacturers in Birmingham. It deals with the question of the design of the laboratory, sampling and storage of samples and the recording of analyses for reference.

The selection and training of the staff and their personal relations also receive attention. It is recommended that "as to qualifications of a scientific nature, a good secondary education without further special knowledge will provide a sufficient basis upon which the rest may be inculcated *on the spot.*" It is difficult to see how an untrained youth can receive adequate tuition in a laboratory where the work is of a routine character and must be done very quickly, especially as it is suggested that he shall take his turn in office, indexing, and photographic work, and clean his own apparatus. The author also considers that "reading up chemistry or physics or any other science at home after work is not to be encouraged." He further states that "the more brilliant members of the routine laboratory should be encouraged to undertake research." The value of research, carried out on such knowledge as the worker has been able to gather at intervals in the laboratory, seems very problematical.

Although the book, as shown above, contains matter of a controversial character, much of it will doubtless prove useful to those contemplating the establishment of a routine testing laboratory. It should be mentioned, however, that no laboratory organisation is described except that which the authors themselves assisted in founding.

THE TEXTILE RECORDER YEAR BOOK, 1923. Compiled and edited by Frank Nasmith. Pp. xcv + 712, 8vo, 7½ × 5½. (Manchester: John Heywood, Ltd., 1923.) Price 7*s.* 6*d.*

A general indication of the contents of this useful year book has already been given in this BULLETIN (1922, **20**, 129). The new edition has been completely revised, additional matter has been introduced into many sections,

and new and improved tables of cotton statistics have been prepared. New chapters have been added dealing with wool marketing, wool spinning, shoddy and mungo, yarn testing, moisture regain by dry fibres, waterproofing, steam turbines for mill driving, and patents.

The value of the book as a work of reference has been fully maintained.

A Textbook of Ore Dressing. By S. J. Truscott, A.R.S.M., M.I.M.M. Professor of Mining at the Imperial College of Science and Technology (Royal School of Mines). Pp. xi + 680, 8vo, 8½ × 6. (London: Macmillan & Co., Ltd., 1923.) Price 40s.

Prof. Truscott's latest contribution to mining literature is, like all his previous works, concise and thorough and clearly expressed. The chapter on comminution includes various types of breakers, rolls, pendulum mills, edge-runners, grinding-pans, ball- and tube-mills, stamps and beater or hammer mills, the portions of the text relating to rolls and tube-mills being especially valuable, from both practical and theoretical points of view. The important subject of sizing is treated under three heads: laboratory sizing, screen sizing, and water sizing or classification. In the last, the fall of particles in water is fully discussed, both mathematically and graphically, and the principal classifiers in use in recent years are well described and illustrated. Water concentration is fully discussed, and the various kinds of jigs, frames, strakes, buddles, sluices, vanners and tables are dealt with. The descriptions of the Frue Vanner and Wilfley Table are especially full, and the latest Deister concentrator, known as the Plateau table, and the recent Butchart table have been included.

The important subject of flotation is treated in two chapters, the first covering processes, machines and agents. In this the history of flotation concentration is impartially stated; then follows a description of flotation machines, flotation agents and mixtures, flotation chemicals and circuits, differential flotation, oxidised-ore flotation, handling of froth concentrate, infiltration, drying and drainage. The next chapter deals with the general aspects and theory of flotation, the last somewhat abstruse subject being very clearly discussed. There is a chapter on magnetic separation, and one on electrostatic, pneumatic and centrifugal separation, and the work closes with short chapters on heat-treatments in ore-dressing, the control of operations, and dressing systems and plants.

The work is profusely illustrated throughout, the line illustrations or diagrams being clear and good.

This textbook will not only be useful to students, but will be indispensable to mine and mill managers, and to mining engineers generally.

LES COLLOIDES DANS L'INDUSTRIE. LE CAOUTCHOUC. By Paul Bary. Pp. vi + 255, 8vo, 10 × 6½. (Paris: Dunod, 1923.) Price fr. 29.

A number of books have been written on rubber in which at least one chapter has been devoted to a brief account of the chemistry of colloids, but this is the first book in which rubber has been considered solely from that point of view.

The book is divided into five chapters, of which the first deals with latex and its coagulation, the second with the chemical properties of caoutchouc, the third with the physical properties of rubber, the fourth with vulcanisation, and the fifth with reclaimed and synthetic rubber.

The author's views on the reversibility of vulcanisation are extremely interesting, especially as they are supported by the results of his own experiments, but they may perhaps not meet with the approval of the majority of rubber chemists.

The book is clearly written and is worthy of study by all who are interested in the problems of rubber chemistry.

THE ENGINEERING OF EXCAVATION. By George B. Massey, Member Am. Soc. C.E. and Am. Soc. M.E., etc. Pp. vi + 376, 8vo, 9¼ × 6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1923.) Price 30s.

This comprehensive and practical book on the engineering of excavation has been written after twenty-four years' study of excavating problems and the application of machinery to them. There are descriptions of revolving shovels, used in stripping iron ore, low-grade copper ore and coal; standard or ordinary steam shovels for excavating dry material; dragline excavators, which have been used for stripping and mining phosphate in Florida; tower excavators, dry-land dredges, trench-digging machines, and various forms of buckets. One chapter is on "hydraulicking" as applied for stripping overburden from iron ore, etc.; and another on drilling and blasting.

A large portion of the work is devoted to excavation by dredges, whilst the final chapter deals with a variety of subjects, such as scows, barges, and dredge hulls, wire-rope, boilers and fuel. The book will prove invaluable to civil and mining engineers, and contractors engaged on large excavation works.

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

The following summaries have been prepared from a selection of the Reports made by the Director of the Imperial Institute to the Dominion, Colonial and Indian Governments.

BRITISH HONDURAS TIMBERS
PART I

Of the numerous timbers occurring in British Honduras only two, mahogany and cedar, are at present exported in quantity, apart from logwood which is used only as a dye. In order to ascertain the value of other timbers, logs of twelve different kinds have been forwarded from British Honduras to the Imperial Institute. The mechanical properties and working qualities of the timbers are being determined in the timber-testing laboratory of the Institute, and the results as they become available are communicated to the Imperial Institute Advisory Committee on Timbers, who, after inspecting the timbers, express their opinion as to the purposes for which they could be utilised and report on their commercial possibilities in this country. The investigation of four of the timbers has been completed and the results are given in the present article.

The local names of these four timbers are "Banak," "Santa Maria," "Sam or Salm Wood" and "Black Poisonwood." The botanical identity of the trees yielding the woods is not known with certainty. Herbarium specimens were sent from British Honduras to the Royal Botanic Gardens, Kew, for determination; but the nature of the material did not admit of definite identification. Banak appears to be a species of *Myristica* near *M. panamensis*, Hemsl.; Santa Maria is probably an undescribed species of *Calophyllum*, although this wood has previously

been thought to be derived from *C. calaba*; Sam Wood was indeterminable, but it is sometimes stated to be a species of *Jacaranda*; Black Poisonwood belongs to the natural order Anacardiaceæ, and is possibly a species of *Mauria*.

With regard to the commercial possibilities of the timbers in this country, the Committee pointed out that before any opinion could be expressed on this point it is essential to have information as to (1) the price at which they can be landed here, (2) the quantities likely to be regularly available for shipment, and (3) the sizes which can be supplied. These particulars are not yet available.

BANAK WOOD (*MYRISTICA* SP)

The log of Banak wood was 9 ft. long and about 18 in. in diameter. The bark was intact, but could easily be pulled off; it was brownish-black, about ⅜ in. thick, and of a friable nature.

The log was sawn into planks 2½ in. thick, which were seasoned by storing for several months in a warm dry place. The three planks from the centre of the log had suffered severely from "heart-shake," but the remainder were practically uncracked. The timber was fairly free from knots, with the exception of a few at the outside. All the planks were badly discoloured and marked with "black line" throughout, probably caused by fungus. The grain was moderately coarse, fairly short in fibre, and generally straight but with a very slight spiral tendency. The wood was pinkish-yellow, darkening on exposure, and showed numerous yellow and grey discolorations bordered with "black line."

In *transverse section* the wood was reddish-brown, with pinkish-yellow patches surrounded by black lines. The pores were numerous and fairly uniformly and densely distributed, usually in pairs; they showed slight resinous contents. The rays appeared as numerous parallel, pinkish lines, barely visible to the naked eye. The rings were ill defined, but were indicated by a narrow band of slightly darker wood. The pith was light reddish-brown, soft, and roughly circular, with a diameter of about ½ inch.

In *radial section* the wood was pinkish-yellow, with occasional greyish discolorations and distinct black line markings. The pores were seen as numerous prominent, orange-coloured grooves, with resinous contents. The rays appeared as well-defined, lustrous, pinkish flakes. The rings were not visible.

In *tangential section* the colour of the wood and the appearance of the pores were as in the radial section. The rays were seen as very numerous, narrow, red lines, tapering at the ends, about $\frac{1}{32}$ inch in length and just visible to the naked eye. The rings were invisible.

Results of Mechanical Tests.—The results of the mechanical tests are summarised in the following table :

Summary of Results of the Mechanical Tests on Banak Wood (Myristica sp.)

		Maximum.	Minimum.	Mean.
A.—*Transverse bending test (central loading):*				
Maximum calculated longitudinal shear	*lb./sq. in.*	345	264	319
Modulus of rupture	,,	9,620	7,350	9,025
Fibre stress at elastic limit	,,	8,090	5,135	6,662
Modulus of elasticity	,,	1,870,000	1,590,000	1,706,000
Elastic resilience	*inch-lb./cu. in.*	2·00	0·86	1·38
B.—*Compression test along the grain* (24 *in. length specimen*):				
Crushing strength	*lb./sq. in.*	4,865	3,514	4,342
Fibre stress at elastic limit	,,	4,600	2,600	3,669
Modulus of elasticity	,,	1,740,000	1,237,000	1,492,000
Elastic resilience	*inch-lb./cu. in.*	5·98	2·30	3·87
C.—*Compression test along the grain* (8 *in. length specimen*):				
Crushing strength	*lb./sq. in.*	5,790	4,910	5,345
Fibre stress at elastic limit	,,	5,570	4,420	4,990
Modulus of elasticity	,,	1,930,000	1,590,000	1,735,000
Elastic resilience	*inch-lb./cu. in.*	7·14	4·05	5·72
D.—*Compression test across the grain*:				
Load at elastic limit	*lb.*	4,900	3,200	3,850
Fibre stress at elastic limit	*lb./sq. in.*	1,219	790	954
E.—*Shearing tests along the grain*:				
Radial—				
Maximum load supported	*lb.*	3,930	2,410	3,312
Shearing strength	*lb./sq. in.*	978	596	829
Tangential—				
Maximum load supported	*lb.*	5,230	4,320	4,941
Shearing strength	*lb./sq. in.*	1,302	1,082	1,229
Specific gravity		0·546	0·484	0·511
Weight per cubic foot	*lb.*	34·1	30·3	31·9
Moisture	*per cent.*	12·10	8·30	10·12

Results of Working Tests

(1) *Sawing.*—The wood cuts easily with hand and power saws.

(2) *Planing.*—A good surface is obtainable with jack and smoothing planes, both along and across the grain.

(3) *Boring.*—Good clear holes are readily obtained with bradawl, gimlet, centre bit and twist drill. There is no tendency to split.

(4) *Nailing and Screwing.*—Nails and screws can be driven in easily, and hold fairly well. The wood does not split.

(5) *Mortising and Dovetailing.*—The wood cuts with facility in a mortising machine ; the joints have little strength.

(6) *Working with Gouge and Chisel.*—The wood is soft and cuts easily.

(7) *Turning.*—The wood turns satisfactorily, but the fibres tear slightly. A good finish is obtainable.

(8) *Glueing.*—Fairly strong joints are obtained, as the wood absorbs the glue well.

(9) *Polishing and Varnishing.*—Satisfactory results are obtained.

(10) *Staining.*—The wood takes stains well, and a fairly good imitation of mahogany is obtainable.

Remarks

Banak is a fairly light, straight-grained wood of good but plain appearance. It possesses, however, only moderate strength and stiffness and does not offer much resistance to crushing or shearing. It is fairly soft and easily worked, does not warp or "check," and is practically free from knots.

The Committee regarded the wood as a useful plain wood which should be serviceable for general construction purposes. They considered, however, that the black lines, which are probably due to fungus, would be detrimental if they are a common feature of the timber.

SANTA MARIA WOOD (*CALOPHYLLUM* SP.)

The log of Santa Maria wood was 8 ft. 9 in. long and about 25 in. in diameter. The bark was intact and firmly attached to the trunk; the internal layers were light brown and corky, the outer being dark brown and harder.

The log was sawn into planks 2½ in. thick, which were seasoned by storing for several months in a warm dry place. The planks were sound except that the three centre planks were cracked up the middle, and no fungoid growth was present. The wood was practically free from knots, but it warped badly. The grain was fairly short-fibred, moderately coarse, and very wavy (alternating spiral). The heartwood was light pinkish-brown and the sapwood of a slightly lighter tint.

In *transverse section* the wood was light pinkish-brown, with greyish concentric shadings. The pores were numerous, well-defined, and arranged in irregular rows; they showed resinous contents. The rays were fairly numerous and appeared as straight, fine, reddish lines just visible to the naked eye. The rings were seen as fine red lines, averaging ten to the inch, and in addition there were concentric shadings. The pith was light brown, soft and of circular form, $\frac{1}{16}$ in. in diameter.

In *radial section* the wood was light pinkish-brown, lustrous, with alternating spiral grain, clearly indicated by colour variations and the appearance of the pores. The latter were seen as long reddish grooves with resinous contents. The rays were in the form of numerous, well-defined, long reddish flakes; the rings appeared as very narrow red lines.

In *tangential section* the wood was slightly darker than in the radial section. The pores appeared as in the radial section; the rays were seen as very numerous minute lines, tapering at the ends. The rings were indicated by narrow irregular bands of darker colour.

Results of Mechanical Tests

The results of the mechanical tests are summarised in the following table:

Summary of Results of the Mechanical Tests on Santa Maria Wood (Calophyllum sp.)

		Maximum.	Minimum.	Mean.
A.—*Transverse bending test (central loading)*:				
Maximum calculated longitudinal shear	*lb./sq. in.*	480	282	417
Modulus of rupture	"	13,440	7,890	11,640
Fibre stress at elastic limit	"	9,390	7,510	8,040
Modulus of elasticity	"	1,706,000	1,271,000	1,434,000
Elastic resilience	*inch-lb. /cu. in.*	3 47	2·12	2·42
B.—*Compression test along the grain* (24 *in. length specimen*):				
Crushing strength	*lb /sq. in.*	6,010	5,360	5,637
Fibre stress at elastic limit	"	4,750	4,020	4,313
Modulus of elasticity	"	1,516,000	1,192,000	1,371,000
Elastic resilience	*inch-lb /cu in.*	6 88	4·56	5·78
C.—*Compression test along the grain* (8 *in. length specimen*):				
Crushing strength	*lb./sq in.*	6,660	5,920	6,315
Fibre stress at elastic limit	"	5,920	4,770	5,500
Modulus of elasticity	"	1,452,000	1,103,000	1,306,000
Elastic resilience	*inch-lb /cu in*	10 34	7·26	9·04
D.—*Compression test across the grain* :				
Load at elastic limit	*lb*	7,100	3,100	4,867
Fibre stress at elastic limit	*lb /sq in.*	1,792	775	1,225
E.—*Shearing tests along the grain* :				
Radial—				
Maximum load supported	*lb*	5,800	5,080	5,562
Shearing strength	*lb /sq in*	1,450	1,283	1,385
Tangential—				
Maximum load supported	*lb.*	7,170	6,110	6,768
Shearing strength	*lb /sq in.*	1,797	1,499	1,682
Specific gravity		0 631	0 514	0·582
Weight per cubic foot	*lb.*	39 4	32 1	36·3
Moisture	*per cent.*	15 3	11 3	13·5

Results of Working Tests

(1) *Sawing.*—The wood cuts easily along and across the grain with both power and hand saws.

(2) *Planing.*—Jack and smoothing planes pick up very badly, but with a fine cut it is possible to obtain a smooth surface.

(3) *Boring.*—Bradawl, gimlet, twist drill and centre bit cut easily and well.

(4) *Nailing and Screwing.*—Nails and screws can be driven in easily and hold well.

(5) *Mortising and Dovetailing.*—The wood cuts fairly well in a mortising machine ; moderately strong joints are obtainable.

(6) *Working with Gouge and Chisel.*—The wood is difficult to work, as it pulls up and tears owing to the wavy grain.

(7) *Turning.*—The wood turns fairly well, but the fibres tear off. Much glass-papering is required for a good finish.

(8) *Glueing.*—Strong joints are obtainable.

(9) *Polishing.*—Satisfactory results are obtained.

(10) *Varnishing.*—A glossy surface is obtainable if the wood is previously sized.

(11) *Staining.*—The wood absorbs the stain well and good results are obtained.

Remarks

Santa Maria is a fairly strong wood of moderate weight. It is moderately stiff, possesses good crushing strength both along and across the grain, and shows satisfactory resistance to shearing.

The wood is easy to work with most machine tools and some hand tools, but the difficulty of obtaining a good surface (except tangentially to the annual rings), owing to the wavy grain " picking up " badly when planed, is a serious disadvantage which would probably preclude the use of the timber for furniture manufacture.

The Committee regarded this wood as of good appearance though somewhat " woolly " in working up. They considered that it should be useful for general framing and construction purposes, since it is fairly strong and of moderate weight, and that in the market it would probably rank just above Gaboon mahogany.

SAM WOOD

The log of Sam wood was 9½ ft. long and about 16 in. in diameter. The bark, which was intact and ¼ to ⅜ in. thick, consisted of a light brown outer corky layer and a bluish-brown, long-fibred, moderately hard inner layer, which peeled easily into long strips.

The log was sawn into planks 2½ in. thick, which were

seasoned by storing for several months in a warm, dry place. The planks were sound, free from knots, and without any trace of fungoid growth, but those cut from the centre of the log had suffered badly from heart-shake. The grain was moderately coarse, fairly long in fibre, and very straight. The sapwood was light greyish-yellow and varied in width from ½ to 1 in.; the heartwood was greyish-brown and slightly lustrous when planed. When the wood was worked it gave off a pleasant odour due to the presence of a small quantity of volatile oil.

In *transverse section* the sapwood was greyish-yellow and the heartwood bluish-brown, with reddish-brown coloration round the heart-shake. The pores were very numerous, uniformly distributed, and fairly conspicuous, but of small size; they showed slight resinous contents. The rays were very numerous and appeared as fine light lines, uniformly distributed. The rings were not well defined, and were irregularly distributed in the log, being arranged considerably more densely on one side of the "centre" of the log than on the other, there being about 12 to 13 rings per inch in the dense wood and 7 to 10 per inch in the more open portion. The pith was very small, brown and circular.

In *radial section* the wood was pinkish-yellow and lustrous, with a greyish transparent appearance in some lights. The pores were not conspicuous, but were seen as narrow, long, straight grooves, slightly darker than the surrounding wood. The rays were conspicuous as dull pinkish-yellow flakes, and the rings were indicated by narrow, darker shaded bands.

In *tangential section* the wood appeared darker in colour than in the radial section. The sapwood was light yellowish-brown, and the heart-wood varied from purplish-brown to light shades of yellow-brown. The pores appeared much as in the radial section but were more conspicuous, the resinous contents being plainly discernible with a small magnifying glass. The rays were very numerous, and appeared as narrow, short lines, tapering at the ends, and of slightly darker colour than the surrounding tissue. The rings were indicated by variations in colour.

Results of Mechanical Tests

The results of the mechanical tests are summarised in the following table :

Summary of Results of the Mechanical Tests on Sam Wood

		Maximum.	Minimum.	Mean.
A.—*Transverse bending test (central loading):*				
Maximum calculated longitudinal shear	*lb./sq. in.*	643	461	568
Modulus of rupture	,,	17,860	12,800	15,815
Fibre stress at elastic limit	,,	10,750	9,523	10,432
Modulus of elasticity	,,	2,194,000	1,716,000	2,031,000
Elastic resilience	*inch-lb./cu. in.*	2·85	2·73	2·79
B.—*Compression test along the grain (24 in. length specimen):*				
Crushing stress	*lb./sq. in.*	7,776	6,839	7,302
Fibre strength at elastic limit	,,	6,863	6,237	6,491
Modulus of elasticity	,,	1,208,000	1,641,000	1,941,000
Elastic resilience	*inch-lb./cu. in.*	10·00	8·41	9·20
C.—*Compression test along the grain (8 in. length specimen):*				
Crushing stress	*lb./sq. in.*	7,884	6,534	7,395
Fibre strength at elastic limit	,,	6,831	5,207	6,248
Modulus of elasticity	,,	2,032,000	1,708,000	1,843,000
Elastic resilience	*inch-lb./cu. in.*	10·64	7·38	8·75
D.—*Compression test across the grain :*				
Load at elastic limit	*lb.*	5,000	2,75	4,150
Fibre stress at elastic limit	,,	1,244	682	1,031
E.—*Shearing tests along the grain :*				
Radial—				
Maximum load supported	*lb.*	7,220	4,000	6,185
Shearing strength	*lb./sq. in.*	1,774	983	1,520
Tangential—				
Maximum load supported	*lb.*	9,840	5,640	7,477
Shearing strength	*lb./sq. in.*	2,484	1,396	1,868
Specific gravity		0·699	0·485	0·603
Weight per cubic foot	*lb.*	43·6	30·3	37·7
Moisture	*per cent.*	11·40	8·65	9·86

Results of Working Tests

(1) *Sawing.*—The wood cuts easily along and across the grain both by power and hand saws.

(2) *Planing.*—A good smooth surface is easily obtainable with jack plane and smoothing plane, the wood having no tendency to " pick up."

(3) *Boring.*—Good clear holes are obtained with bradawl, gimlet, and centre bit, but there is a slight tendency to split, especially near the edges ; twist drills tend to bind.

(4) *Nailing and Screwing.*—Both nails and screws hold

well along and across the grain, but the wood shows a slight tendency to split when they are driven in.

(5) *Mortising and Dovetailing.*—The wood cuts easily and cleanly in the mortising machine, but joints of only fair strength are obtainable.

(6) *Working with Gouge and Chisel.*—The wood cuts easily, but has a tendency to split when carved.

(7) *Turning.*—The wood turns well, but the fibres tear slightly. A good finish is obtainable with sandpaper, but there is no strength in thin flanges.

(8) *Glueing.*—The joints obtained are not very strong.

(9) *Polishing and Varnishing.*—The wood has a good appearance when polished or varnished.

(10) *Staining.*—The wood takes stain well.

Remarks

The results of the foregoing tests show that Sam wood is a moderately strong, fairly stiff wood, with good working properties. It has but little tendency to warp or "check," is very straight in grain, and cleaves easily and well.

The wood has a fairly high modulus of elasticity and good crushing and shearing strengths, but in the present instance it showed great variation in density in different parts of the specimen.

The Committee considered that whilst this wood showed no specially attractive character it was of good general appearance, and might be suitable for furniture though it would probably be more useful for general construction work.

Black Poisonwood (*Mauria* sp ?)

The log of Black Poisonwood was 9 ft. long and about 18 in. in diameter. The bark was dark brown and approximately ½ in. thick ; it was intact at first, but fell away after the log had been sawn.

The log was cut into planks 2½ in. thick, which were seasoned by storing for several months in a warm dry place. Many of the planks were badly cracked, and in some cases a number of parallel "checks" were visible, about an inch apart and running diagonally to the longi-

tudinal axis of the plank. There was no indication of any internal fungoid growth in the wood. The timber was practically free from knots. The grain was slightly wavy or alternating spiral, fairly long in fibre and moderately fine and dense. The heartwood was reddish-brown, with narrow black markings, and the sapwood light yellow-brown with greyish discolorations.

In *transverse section* the sapwood was light yellow-brown with greyish discolorations, and the heartwood reddish-brown with black markings which roughly coincided with the annual rings. The pores were numerous, fairly large and well defined, and evenly distributed, except near the rings; they had resinous contents. The rays were seen as numerous, fine, parallel, light-coloured lines, in some cases showing slight curvature. The rings were fairly well defined, averaging 8 or 9 to the inch. The pith was brown, soft, and almost circular, with a diameter of about $\frac{1}{16}$ in.

In *radial section* the wood had a lustrous appearance and was reddish-brown with black stripings. The pores appeared as numerous, pinkish, fairly long, straight grooves completely filled. The rays were seen as numerous pinkish flakes; the rings were only faintly indicated.

In *tangential section* the wood was darker and less lustrous than in the radial section, and showed broad black markings. The pores appeared as in the radial section. The rays were seen as very numerous pinkish lines, tapering at the ends, and about $\frac{1}{16}$ in. long; the rings were invisible.

Results of Mechanical Tests

The results of the mechanical tests are summarised in the following table:

Summary of Results of the Mechanical Tests on Black Poisonwood (Mauria sp. ?)

		Maximum.	Minimum.	Mean
A.—*Transverse bending test (central loading):*				
Maximum calculated longitudinal shear	*lb./sq. in.*	645	521	579
Modulus of rupture	"	17,980	14,880	16,236
Fibre stress at elastic limit	"	10,770	9,300	10,020
Modulus of elasticity	"	1,840,000	1,466,000	1,670,000
Elastic resilience	*inch-lb./cu. in.*	3·79	2·51	3·15

		Maximum.	Minimum.	Mean.
B.—*Compression test along the grain* (24 *in. length specimen*):				
Crushing strength . .	*lb./sq. in.*	6,930	6,450	6,712
Fibre stress at elastic limit	,,	5,480	4,470	5,140
Modulus of elasticity .	,,	2,035,000	1,434,000	1,652,000
Elastic resilience .	*inch-lb./cu. in.*	7·70	5·66	6·75
C.—*Compression test along the grain* (8 *in. length specimen*):				
Crushing strength . .	*lb./sq. in.*	7,990	6,840	7,295
Fibre stress at elastic limit	,,	6,670	5,440	5,878
Modulus of elasticity .	,,	1,788,000	1,179,000	1,519,000
Elastic resilience .	*inch-lb./cu. in.*	12·98	6·42	9·31
D.—*Compression test across the grain*:				
Load at elastic limit .	*lb.*	13,000	6,100	8,680
Fibre stress at elastic limit	*lb./sq. in.*	3,240	1,520	2,157
E.—*Shearing tests along the grain*:				
Radial—				
Maximum load supported	*lb.*	7,240	5,520	6,620
Shearing strength .	*lb./sq. in.*	1,770	1,360	1,628
Tangential—				
Maximum load supported	*lb.*	10,050	7,800	9,142
Shearing strength .	*lb./sq. in.*	2,460	1,905	2,240
Specific gravity		1·070	0·952	1·008
Weight per cubic foot . .	*lb.*	66·9	59·5	63·0
Moisture	*per cent.*	22·4	15·4	18·6

Results of Working Tests

(1) *Sawing.*—The wood is tough to cut with hand or power saws. It cuts cleanly, but tends to grip hand-saws.

(2) *Planing.*—Planing is difficult. It is necessary to take a fine cut, and there is a tendency to "pick up."

(3) *Boring.*—Centre bits cut with difficulty; twist drills cut fairly well but heat up and are gripped by the wood. Bradawls are useless, but gimlets can be employed.

(4) *Nailing and Screwing.*—Nails are difficult to drive in, but hold well. Screws require fair-sized holes; otherwise they break off when screwed in.

(5) *Mortising and Dovetailing.*—The wood is difficult to cut in a mortising machine. Strong joints are obtainable.

(6) *Working with Gouge and Chisel.*—The wood is hard to work, but the results are good.

(7) *Turning.*—The wood is hard to work and blunts the tools, but gives satisfactory results. A polished surface of excellent appearance is obtainable with sandpaper.

(8) *Glueing.*—The wood is non-absorbent, and the glued joints are consequently weak.

(9) *Polishing.*—Care is needed in polishing, but fairly satisfactory results are obtained.

(10) *Varnishing.*—Satisfactory results are obtainable.

(11) *Staining.*—Only a moderately good effect is obtained as the wood does not absorb the stain readily.

Remarks

Black Poisonwood is a heavy, hard, fairly long-fibred wood, of good strength and flexibility. It has good crushing strength, especially across the grain, and offers a fairly high resistance to shearing.

Owing to its toughness the wood is difficult to work with hand or power tools. It has a tendency to "check" when first cut, but does not warp appreciably.

The Committee regarded this wood as an interesting but heavy wood which might find a market for decorative purposes, and for counter-tops and heavy furniture where weight is of secondary importance. They considered, however, that the grain would not be universally admired, and that the timber would probably be difficult to work on account of its hardness.

SILK FROM EAST AFRICA

In connection with the investigation of raw silk from various countries in the Empire, which is being carried out in consultation with the Imperial Institute Advisory Committee on Silk Production (see "Report on the Operations of the Imperial Institute," this Bulletin, 1923, **21**, 82), mulberry silk cocoons from Kenya and Uganda have recently been examined at the Imperial Institute. An account of the results of their investigation is given in the following pages.

Kenya

The silkworms producing the cocoons received from Kenya had been raised from "seed" supplied by the Imperial Institute Advisory Committee on Silk Pro-

duction for experimental cultivation in the Colony, in accordance with an arrangement made with the Director of Agriculture at an interview with the Committee in 1920.

The cocoons were of normal appearance, clean, free from stain and mould, cream to pale pinkish-yellow externally and bright yellow within. No pierced cocoons were observed in the sample. The average weight of the cocoons was 0·5 gram.

The cocoons were found to vary from 1·2 to 1·5 in. in length, with an average of 1·3 in., and from 0·6 to 0·8 in. in diameter, with an average of 0·7 in. They consisted of silk 44 per cent. and chrysalis 56 per cent.

The diameter of the double fibre (or "bave") measured from 0·0006 to 0·0013 in. with an average of 0·0010 in., and that of the single fibre (or "brin") from 0·00025 to 0·0006 in., with an average of 0·00045 in.

After being freed from chrysalides the cocoons contained 9·4 per cent. of moisture, and lost 27·8 per cent. by weight (expressed on the moisture-free silk) on degumming by boiling with a 1 per cent. soap solution. The degummed silk was practically white and appeared to be normal in strength and general properties.

The cocoons were inspected by the Committee, who regarded them as clean, well-shaped, and of good appearance. The actual quality of the silk could not, however, be definitely determined except by carrying out practical trials, and though the quantity of cocoons available was insufficient for weaving tests, the Committee arranged for a preliminary reeling trial to be carried out at a filature in Lyons.

In the report on the results of this trial, it was stated that the cocoons were irregular in size and very hard when immersed in the reeling basins, so that the reeling operation was difficult. The yield of silk was satisfactory, but the product obtained was coarser than would have been expected from the satisfactory appearance of the cocoons.

The reeled silk was submitted to the official Conditioning House at Lyons for examination, and was found to be of good tenacity but only moderately satisfactory as regards elasticity.

The silk obtained in the reeling trials was considered by the Committee to be of promising quality. It was described as a soft silk which appeared to be somewhat gummy, a condition which would result in additional loss when the material is degummed before being made into yarn. The thread was clean, but possessed little brilliancy as compared with first quality European silks. The reeled silk was valued at 31*s*. per lb. in the United Kingdom (March 1923).

It would be unsafe to generalise on the basis of the present small sample of cocoons, but it may be stated that on the whole the results are satisfactory for a first trial. The defects of the cocoons as reported by the reelers would no doubt disappear as further experience is gained in raising and feeding the worms under the conditions obtaining in Kenya. The general character of the silk was very promising, and in this case also improvement may be looked for with increased experience.

The Committee consider it very desirable that the experiments with mulberry silk-worms should be continued in Kenya, as a final test of a silk can only be obtained as a result of weaving trials with a bulk consignment. It has been pointed out to the Kenya authorities that if a consignment of not less than 100 lb. of the cocoons can be sent to the Imperial Institute it will be possible to arrange for further reeling trials and for weaving experiments with the silk obtained.

Uganda

The cocoons received from Uganda were of dark cream colour, oblong in shape, with rounded ends, and somewhat constricted in the centre. The internal surface of the cocoons was of a pale yellow tint. A fair number of the cocoons showed dark brown stains. Not many double cocoons were present, and only a few pierced cocoons were found in the sample.

The cocoons averaged about 0·4 gram in weight, and measured from 1·1 to 1·8 in. in length, with an average of 1·3 in. The average diameter was 0·7 in.

The diameter of the double fibre (or " bave ") measured

up to 0·0010 in. and that of the single fibre (or "brin") from 0·0002 to 0·0006 in., being mainly 0·0004 in.

After degumming, the silk was almost white, and appeared to be normal in strength and general properties.

The cocoons were inspected by the Silk Committee, who described them as uneven in size, variable in colour, and of poor quality, many of them being stained, probably a result of disease which appeared to have affected the worms. In the opinion of the Committee the defects of the cocoons were attributable to the difficulty which had been met with in feeding and raising the worms.

It was decided to remove the least satisfactory cocoons and to arrange for reeling trials with the remainder to be carried out at a filature in Lyons. The results were on the whole favourable, the "rendement" (a figure indicating the quantity of cocoons required to yield 1 kilogramme of silk) being good, and the winding tests satisfactory. The elasticity was somewhat low, but the tenacity proved to be adequate.

On the whole the results of the reeling trials were considered by the Committee to be promising, so far as the cocoons actually used were concerned.

The reeled product was examined by the Committee and found to be a soft spongy silk, affording a clean thread but lacking in brilliancy. The Committee valued it at 31*s.* per lb. in the United Kingdom (March, 1923), but were of opinion that if improved methods of raising the cocoons were adopted a silk of far better quality should be obtainable.

The Committee considered that in view of the difficulties experienced in raising the cocoons, the results obtained in the present instance were not unsatisfactory. They regarded it, however, as unwise to base a definite opinion respecting the technical and commercial value of the silk on the results of the reeling trials carried out in this case, as the cocoons used formed part of a small sample from which all those of poor quality had been eliminated.

The Committee recommended further reeling trials with a larger quantity of cocoons, raised under better conditions. For this purpose it has been suggested that

not less than 100 lb. of dry cocoons should if possible be forwarded to the Imperial Institute so that arrangements may be made for weaving trials, which would be necessary as a final test of the technical value of the silk, but that if this quantity of cocoons is not likely to be available for some time, a quantity of (say) 25 to 50 lb. should be sent in order to enable proper reeling trials to be carried out.

General Remarks

As regards the general question of the prospects of sericulture in countries like Kenya and Uganda which are considering the industry for the first time, the following observations were made by the Committee.

It will be found very difficult to export the cocoons to Europe for reeling, pay the freight charges, and obtain a profit on the undertaking. Moreover, in the early stages of the industry, producers of cocoons would have to be content with a price lower than the ruling market price for cocoons until the qualities of the cocoons became recognised. Thus, whereas the current price of the best French cocoons (dry) is about 7*s.* per lb., ex store, cocoons from new sources, even if of good quality, would at first probably not average more than 4*s.* to 5*s.* per lb.

In the opinion of the Committee, the only reliable way to establish a silk industry in Kenya or Uganda would be for arrangements to be made (officially or otherwise) to cover the loss on sales of cocoons until it is possible to establish a small filature and reel the silk locally; after which the industry should be profitable, provided that the silk is of good quality and the reeling is properly done.

THE MEDICINAL VALUE OF ONCOBA OILS

In 1908 seeds of the "Gorli" plant (*Oncoba echinata*) from Sierra Leone were examined at the Imperial Institute and found to contain 46 per cent. of a hard, white crystalline fat. Subsequent examination of the fatty acids of which the fat is composed showed that they consist of 87·5 per cent. of chaulmoogric acid and 12·5 per cent. of unsaturated liquid acids (this Bulletin, 1913, **11**, 439; Goulding and Akers, *Proc. Chem. Soc.*, 1913, **29**, 197).

Chaulmoogric acid is the principal constituent of chaulmoogra oil, obtained in India from the seeds of *Taraktogenos Kurzii*, and of the oils of species of *Hydnocarpus*. These oils find a use in medicine as a cure for leprosy and other skin diseases, and it seems probable that if the fat of Gorli seeds could be obtained in sufficient quantity, it could be employed for the same purpose.

Other species of *Oncoba* occur in parts of Africa, and the seeds of *O. spinosa* from South Africa have recently been examined at the Institute in order to ascertain whether they also yield an oil containing chaulmoogric acid.

The material received consisted of spherical fruits about 1¾ in. in diameter, having a thin hard shell and containing seeds embedded in dark brown pulp.

The seeds, which were in sound condition, were small, flat and oval, and varied in colour from brown to very dark reddish-brown. They contained 6·5 per cent. of moisture, and yielded on extraction with petroleum ether 35·2 per cent. of a brownish-yellow oil, equivalent to a yield of 37·6 per cent. from the moisture-free seeds. When spread on glass, the oil dried in from three to four days.

The oil was submitted to chemical examination, and the results are shown in the following table in comparison with those obtained with *O. echinata* oil.

	O. spinosa Oil.	*O. echinata* Oil
Specific gravity	0·9303 at 15/15° C	0·898 at 100/15° C.
Solidifying point of fatty acids ° C	23·4	57·8
Acid value	12·1	4·5
Saponification value	192·2	192·4
Iodine value . *per cent.*	177·0	99·7
Refractive index at 40° C	1·474	—
Specific rotation of fatty acids $[\alpha]_D^{18}$	nil	+ 52·5°
Unsaponifiable matter *per cent.*	1·3	1·6
Volatile acids, soluble	0·5	nil
„ „ insoluble	0·45	—
Chaulmoogric acid *per cent.*	nil	84·4

The results of the investigation show that the oil of *O. spinosa* differs considerably in its constants from the oil of *O. echinata*, and that unlike the latter it contains no chaulmoogric acid. The oil would therefore not have the medicinal properties of the oil of *O. echinata* or of chaulmoogra oil.

O. spinosa oil is a drying oil and might be utilised for paint and varnish making. The difficulty of separating the seeds from the pulp of the fruits, however, might militate against their commercial utilisation.

LOCAL CLAYS FOR BRICK AND TILE MANUFACTURE IN MAURITIUS

In the " Report on the Operations of the Imperial Institute," published as No. 1 of this volume of the Bulletin, reference is made (p. 34) to the examination of brick- and tile-making materials from various countries of the Empire. Detailed reports on these materials from Uganda, Kenya and Nigeria have already been published in this Bulletin (1921, **19**, 297, 303 ; 1922, **20**, 302), and in the present article certain clays from Mauritius are dealt with.

In 1921 three clays, obtained from different parts of the island, were received, and brick-making trials were carried out with them at the Imperial Institute. In the following year larger quantities of each clay were supplied, which were examined as materials for the manufacture of tiles and drain pipes. The clays were as follows :

No. 1. " *From Calebasses.*"—A dark red clay, containing a number of small lumps of hæmatite and hard clay. No felspar or coarse quartz was observed.

No. 2. " *From La Ferme.*"—A very hard, dark grey clay, containing a few small lumps consisting of oxides of manganese and iron.

No. 3. " *From La Nicolière.*"—A soft yellow clay, containing some sandy matter consisting of hæmatite, limonite, quartz and decomposed felspar.

I. Brick-making Trials

No. 1 (*Calebasses*).—This clay, after being ground to pass a sieve having 20 meshes to the linear inch, formed a very plastic mass when mixed with water.

Bricks made from the ground crude clay broke up on being fired to a temperature of 1,040° C. for six hours, probably on account of the excessive shrinkage, which amounted to 18·7 per cent. The clay is therefore quite unsuitable, in the crude state, for the manufacture of

bricks, and experiments were made to determine whether the addition of "grog"* would effect any improvement.

Bricks made from mixtures of the crude clay and grog, and containing respectively 40 per cent. and 60 per cent. of the latter material, were fired to a temperature of about 1,040° C. for six hours, with the results shown in the following table:

	Crude clay.	Clay 60 per cent. Grog 40 per cent.	Clay 40 per cent. Grog 60 per cent.
Water added . . . *per cent.*	30	27	28
Temperature of firing	1,040° C.	1,040° C.	1,040° C.
Time of firing . . . . *hours*	6	6	6
Shrinkage on air-drying *per cent.*	12·4	6·7	4·2
Additional shrinkage on firing *per cent.*	6·3	4·3	2·3
Total shrinkage . . *per cent.*	18·7	11·0	6·5
Tensile strength . *lb. per sq. in.*	—	183	—
Porosity (water absorption) *per cent.*	—	35·4[1]	—
Ring	—	Fairly good	Bad
Colour	Terracotta	Terracotta	Light Terracotta

[1] *As compared with 23·4 for an ordinary Sittingbourne red building brick.*

The quantity of clay available was insufficient to permit of the determination of the crushing strength of the bricks. The brick made from the mixture containing 40 per cent. of grog was fairly strong but had a high porosity, and the shrinkage was in excess of the limit of about 8½ per cent. usually permissible.

The brick made from the mixture containing 60 per cent. of grog was weak and an attempt was therefore made to improve its strength by re-firing it to a temperature of about 1,160° C. for two hours, but no perceptible increase in strength resulted.

Both bricks containing grog had warped badly. It was thought that the warping might be due to incipient softening of the bricks on account of their low fusibility, but this was found not to be the case, as cones made of the mixture containing 60 per cent. of grog and fired to a temperature of 1,230° C. showed only slight vitrification.

Fairly strong bricks can be made from this clay from Calebasses by using a clay-grog mixture containing about 40 per cent. of grog, but on account of the high shrinkage

* The "grog" was prepared by firing some of the raw clay to a temperature of about 1,000° C. for six hours, and grinding the burnt product to pass a 20-mesh sieve.

and the tendency of the bricks to warp extreme care would be necessary in firing.

No. 2 (La Ferme).—This clay, after being air-dried and ground to pass a sieve of 20 meshes to the linear inch, formed an extremely plastic mass when mixed with water.

A brick made from the ground clay alone showed a shrinkage on air-drying of 16·0 per cent., but the further shrinkage could not be determined as the brick fell to pieces when fired. The crude clay was therefore useless for brick-making and trials were accordingly made with mixtures containing grog, prepared as already described. These bricks were fired to a temperature of about 1,040° C. for six hours, with the results shown in the following table :

	Crude clay.	Clay 60 per cent. Grog 40 per cent.	Clay 40 per cent. Grog 60 per cent.
Water added . . *per cent.*	34	28	29
Temperature of firing . . .	1,040° C.	1,040° C.	1,040° C.
Time of firing . . . *hours*	6	6	6
Shrinkage on air drying . *per cent.*	16·0	8·9	4·5
Additional shrinkage on firing *per cent.*	—	2·7	2·0
Total shrinkage . . *per cent.*	—	11·6	6·5
Tensile strength . *lb per sq. in.*	—	181	—
Porosity (water absorption) *per cent.*	—	31·4[1]	23·6[1]
Ring	—	Good	Good
Colour	—	Light Indian red	Light Indian red

[1] *As compared with 23·4 for an ordinary Sittingbourne red building brick.*

The two bricks containing grog were fairly strong, and suitable for ordinary building purposes. The brick made from the mixture containing 60 per cent. of grog was the better of the two, as the shrinkage was low and the material being less sticky was easier to work than the 40 per cent. mixture. The tensile strength of the brick containing 40 per cent. of grog was practically the same as that of the corresponding brick made with Clay No. 1 from Calebasses.

The quantity of clay available was insufficient for the determination of the crushing strength of the bricks or of the tensile strength of the brick containing 60 per cent. of grog.

No. 3 (La Nicolière).—This clay, when ground to pass a 20-mesh sieve, formed a fairly plastic mass with water, but it was rather difficult to mould satisfactorily.

Bricks made with the crude clay and with a mixture containing 40 per cent. of grog were fired to a temperature

of 1,040° C. for six hours, and the results obtained are shown in the following table :

		Crude clay.	Clay 60 per cent. Grog 40 per cent.
Water added	*per cent.*	32·5	34·0
Temperature of firing.		1,040° C.	1,040° C.
Time of firing	*hours*	6	6
Shrinkage on air-drying	*per cent.*	7·9	2·8
Additional shrinkage on firing	*per cent.*	3·9	2·5
Total shrinkage.	*per cent.*	11·8	5·3
Tensile strength	*lb. per sq. in.*	91	57
Porosity (water absorption)	*per cent.*	58·9 [1]	63·2 [1]
Ring		Fairly good	Fairly good
Colour		Dark orange red	Dark orange red

[1] *As compared with 24·5 for a Bracknell "rubber" brick.*

The bricks made from the crude clay were rather soft and very porous, but such products might possibly serve for use as "rubbers." The brick made with the 40 per cent. grog mixture was too weak to be of any value and it was therefore re-fired to a temperature of about 1,160° C. for two hours, but no appreciable increase in strength was observed.

Summary

The results obtained show that clays No. 1 (Calebasses) and No. 2 (La Ferme) are unsuitable for use in the crude state for the manufacture of bricks. By admixture with suitable quantities of grog, fairly strong bricks can be made with these two clays, but those made with No. 1 have a tendency to warp and the range of satisfactory mixtures which can be made with this clay and grog is less than in the case of No. 2, which is thus the better of the two clays.

Clay No. 3 (La Nicolière) is only suitable for use in the crude state for the manufacture of soft, porous bricks, which might possibly serve as "rubbers" if their very high porosity is not disadvantageous.

It is possible that prolonged weathering might improve the quality of all these clays, and render them more suitable for brick-making purposes, but this point could only be decided by prolonged trials. Improvement might possibly be effected in Nos. 1 and 2 by heating them to about 200° C. before grinding, but owing to lack of material this point could not be investigated.

II. Tiles

No. 1 (*Calebasses*).—It was shown in the section on bricks (p. 587) that this clay has a high shrinkage and shows a tendency to break up on firing. It is evident therefore that in the raw state it would not be suitable for the manufacture of tiles.

The mixture found most suitable for the manufacture of bricks from this clay was one containing 60 per cent. of clay and 40 per cent. of grog. Tiles were made from a similar mixture which had been ground to pass a sieve of 20 meshes to the linear inch, and were fired at a temperature of 1,030° C. for six hours, the total time of firing being twenty-four hours.

The products so obtained were tested with the results shown in Table A.

As stated on p. 590 it was thought that a process of pre-heating clays Nos. 1 and 2 might effect an improvement in their quality. A quantity of clay No. 1 was therefore heated to a temperature of 300° C. for about four hours, and was then ground to pass a 20-mesh sieve and mixed with water. It was now found that the clay had lost its extreme plasticity and was easy to work. Tiles were made from the pre-heated clay alone and also from a mixture of 60 per cent. of the pre-heated clay with 40 per cent. of clay No. 3 and were fired as before.

The results of the above trials are tabulated below.

TABLE A

		60 per cent. Clay No. 1, 40 per cent. Grog.	Clay No. 1 (pre heated).	60 per cent Clay No. 1 (pre-heated), 40 per cent. Clay No. 3.
Water added	*per cent.*	26·8	30·0	30·2
Maximum temperature		1,030° C	1,030° C.	1,030° C.
Duration of firing at maximum temperature	*hours*	6	6	6
Total time of firing	*hours*	24	24	24
Shrinkage on air-drying	*per cent.*	8·7	3·2	4·9
Shrinkage on firing	*per cent.*	3·6	14·0	12·1
Total shrinkage	*per cent.*	12·3	17·2	17·0
Cross breaking stress:				
(*a*) Unfired	*lb. per sq. in.*	276	—	—
(*b*) Fired [1]	*lb. per sq. in.*	929	1,220	1,148
Warpage on firing (deflection of 6 in tile from straight)	*in.*	0·22	nil	0·03
Porosity of the fired tile (determined by water absorption) [1]	*per cent.*	34·4	20·5	30·6

[1] *A commercial roofing tile of good quality examined in comparison gave 2,008 lb. per sq. in. for the cross breaking stress and had a porosity of 30·7 per cent.*

It will be seen that the tiles made from the mixture of the untreated clay with grog had warped badly, but were fairly strong, the transverse breaking stress being about half that of a commercial roofing tile of good quality. The porosity was approximately equal to that of the commercial tile.

As stated on p. 589, extremely careful firing would be necessary with this clay on account of its tendency to warp.

Very marked improvement was effected by pre-heating the clay before use and thus the tendency of the raw clay body to disintegrate on firing was overcome, warpage was almost eliminated, and a product was obtained which was stronger than that yielded by the raw clay-grog mixture previously tried.

The shrinkage on air-drying was greatly reduced, but the total shrinkage was still high.

No. 2 (La Ferme).—Tiles were made from a mixture of 60 per cent. of the clay and 40 per cent. of grog, but a weak product was obtained on firing. It was thought possible that, by substituting Clay No. 3 for grog, a stronger material might be produced, and tiles were therefore made

TABLE B

	60 per cent. Clay No. 2, 40 per cent. Grog.	40 per cent. Clay No. 2, 60 per cent. Clay No. 3.	30 per cent. Clay No. 2, 70 per cent. Clay No. 3.	80 per cent. Clay No. 2 (pre-heated), 20 per cent. Clay No. 1.
Water added . *per cent.*	28·0	27·5	28·0	26·7
Maximum temperature .	1,030° C.	1,030° C.	1,030° C.	1,030° C.
Duration of firing at maximum temperature. *hours*	6	6	6	6
Total time of firing . *hours*	24	24	24	24
Shrinkage on air-drying *per cent.*	8·5	8·5	8·5	1·7
Shrinkage on firing *per cent.*	1·7	10·1	10·5	9·7
Total shrinkage *per cent.*	10·2	18·6	19·0	11·4
Cross breaking stress:				
(*a*) Unfired *lb. per sq. in.*	230	179	236	—
(*b*) Fired[1] *lb. per sq. in.*	395	957	1,083	1,246
Warpage on firing (deflection of 6 in. tile from straight) . . *in.*	nil	0·12	0·12	nil
Porosity of the fired tile (determined by water absorption)[1] . *per cent.*	37·9	29·1	32·4	20·8

[1] *A commercial roofing tile of good quality examined in comparison gave 2,008 lb. per sq. in. for the cross breaking stress and had a porosity of 30·7 per cent.*

from mixtures of Clay No. 2 with varying proportions of Clay No. 3, both clays being ground to pass a sieve of 20 meshes to the linear inch.

This clay was pre-heated (as in the case of No. 1), but owing to the poor plasticity of the resulting product tiles were not made from it alone but from a mixture of 80 per cent. of the pre-heated clay with 20 per cent. of raw clay No. 1, the latter being added as a binding agent. These tiles were fired as before.

The results of the above series of trials are given in Table B, p. 592.

The results show that mixtures of clay No. 2 with grog did not give tiles of sufficient strength. Improvement in strength was effected by the use of clay No. 3 in place of grog, but in this case the shrinkage was very high and there was considerable warpage.

Great improvement in all respects was effected by pre-heating the clay. The tendency of the raw body to disintegrate on firing was overcome, the shrinkage and porosity were reduced to a reasonable amount, the warpage eliminated, and a fairly strong product was obtained.

TABLE C

	Clay No. 3.	80 per cent. Clay No. 3, 20 per cent. Clay No. 1.	70 per cent. Clay No. 3, 30 per cent. Clay No. 1.	60 per cent. Clay No. 3, 40 per cent. Clay No. 1.
Water added . *per cent.*	32·5	28·3	26·5	29·2
Maximum temperature .	1,030° C.	1,030° C.	1,030° C.	1,030° C.
Duration of firing at maximum temperature. *hours*	6	6	6	6
Total time of firing . *hours*	24	24	24	24
Shrinkage on air-drying *per cent.*	7·1	6·5	8·4	8·8
Shrinkage on firing *per cent.*	5·4	9·9	11·2	13·2
Total shrinkage *per cent.*	12·5	16·4	19·6	22·0
Cross breaking stress:				
(*a*) Unfired *lb. per sq. in.*	267	356	396	188
(*b*) Fired[1] *lb. per sq. in.*	767	1,500	1,766	1,710
Warpage on firing (deflection of 6 in. tile from straight) . . *in.*	nil	0·04	0·09	0·05
Porosity of the fired tile (determined by water absorption)[1] *per cent.*	53·6	38·1	35·3	32·6

[1] *A commercial roofing tile of good quality examined in comparison gave 2,008 lb. per sq. in. for the cross breaking stress and had a porosity of 30·7 per cent.*

No. 3 (La Nicolière).—Tiles were made from the neat clay and from mixtures of the clay with varying proportions of Clay No. 1. No mixtures were made with grog, as the brick-making trials with No. 3 had shown that such mixtures yielded a weak, very porous material.

The results obtained on firing these tiles are shown in Table C, p. 593.

The results show that a weak and porous product was obtained when the clay was used alone, but that strong tiles were produced from mixtures with Clay No. 1. With these mixtures, however, the shrinkage was high, and there was a tendency to warp. Very careful firing would therefore be necessary to ensure good results.

Summary

The results obtained show that strong tiles can be produced from the untreated clays by using them in suitable admixture. The best results are obtained by using Clay No. 3 in conjunction with No. 1 or No. 2, and if the firing can be carried out sufficiently carefully to overcome the difficulties caused by high shrinkage and warpage, satisfactory tiles would be produced.

Great improvement can be effected with these clays by pre-heating, which eliminates the tendency of the raw clay to break up and warp on firing, and yields a product suitable for the manufacture of tiles. In these trials the clays were pre-heated at 300° C. for four hours, but a somewhat lower temperature (not, however, below 200° C.), would probably give equally good results.

It should be noted that though strong tiles can be produced from these clays, their strength is in all cases somewhat inferior to that of the commercial tiles of good quality which were tested in comparison. If practical trials show that the tiles are not sufficiently durable, or if semi-vitrified tiles are required, the effect of adding small quantities of very finely powdered fusible material, such as felspar or glass, to the ground clay, should be determined. The effect of prolonged weathering should also be investigated, as suggested in the section on bricks.

III. Drain Pipes

Two classes of pipes may be considered under the term "drain pipes," viz. sewage pipes and agricultural drain pipes.

Sewage pipes are generally made of a vitrifiable clay, or of a fire-clay to which has been added felspar or other fluxing material. They are usually covered with a salt glaze and should therefore have a siliceous body. The Mauritius clays, which are very ferruginous and contain little free silica, would be unsuitable for the production of sewage pipes, since the composition of the body would not permit of the ready application of the perfect glaze necessitated by the porous nature of the fired material.

The clays were tested as to their suitability for the production of agricultural drain pipes, which are usually made from ordinary brick clays.

No. 1 (Calebasses).—The same mixture of clay and grog found most suitable for the manufacture of bricks and tiles was used for the production of pipes.

The pipes were fired under the same conditions as the tiles. Like the tiles and bricks, they had a tendency to warp, but were fairly strong and should be suitable for agricultural purposes.

An attempt to glaze some of the pipes with salt was unsuccessful, no sign of a glaze being produced, owing to the non-siliceous nature of the body.

No pipes were made from the pre-heated material, but the greater ease in firing caused by the elimination of the tendency to warp would justify manufacturing trials being made with it. The somewhat high shrinkage on firing of the pre-heated clay is, in this case, the chief objection to its use, but this might be surmounted in practice.

No. 2 (La Ferme).—Pipes were made from mixtures (of raw clays) corresponding to those from which tiles were made, and were fired under the same conditions as the tiles. The pipes made from the mixture of 60 per cent. clay and 40 per cent. grog were weak, but those made from the mixture with Clay No. 3 were fairly strong. The

high shrinkage (shown in the table B on p. 592) and the tendency to warp were the chief defects.

No pipes were made from the pre-heated clay, but the results obtained in the tile-making tests indicate that good results could probably be obtained.

No. 3 (La Nicolière).—Strong drain pipes can be produced from mixtures of this clay with No. 1 in the same proportions as used for tiles. The mixture containing 80 per cent. of No. 3 is the more porous, and would therefore probably be the most suitable for agricultural purposes.

Summary

None of the clays would be suitable for the manufacture of sewage pipes, but drain pipes which would probably be suitable for agricultural purposes can be produced from the clays by the use of mixtures corresponding to those found most successful in the tile-making trials. It is probable that good results could also be obtained by the use of pre-heated clay.

SPECIAL ARTICLE

COTTON GROWING IN AUSTRALIA

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Australia is slightly larger than the United States of America, and about 1,150,000 square miles, or more than one-third of it, lies within the tropics. Cotton can be grown in some parts of the country, but extensive areas are unadapted for the cultivation on account of the scanty or unsuitably distributed rainfall. The American cotton belt lies between 25° and 37° north latitude; the northern and southern limits of the Australian continent are the parallels of latitude 10° 4′ south and 39° 8′ south. Owing to its insular geographical position, and the absence of striking physical features, Australia is, on the whole, less subject to extreme weather conditions than are regions in similar latitudes in other parts of the world.

Early Efforts to Grow Cotton

Spasmodic efforts have been made to grow cotton in Australia since 1788, when Governor Philip brought cotton seed from South America to plant in Sydney It is reported that "the plants raised from these seeds flourished and produced much cotton." The Governor of Brisbane mentioned, in an address which he made to the Agricultural Society in 1825, that the experiments conducted with cotton had established the fact that this crop could be successfully cultivated. At this period, Australian-grown cotton was favourably reported on in England, and articles were manufactured from it and sent back to the country. About 1845, Dr. Lang, a strong advocate of cotton growing in Australia, stated: "My efforts therefore at this period in connection with cotton cultivation in Australia originated in a general measure, if not exclusively, in my desire to get out to our colonies a population of the right description from Great Britain and Ireland. Cotton cultivation I conceived was to be the means, but this was the end." He was successful in sending to Moreton Bay about 600 persons from England.

In 1852, the first bale of Australian cotton was produced, on a measured acre of land, at a cost of £5, and it sold at the rate of 1*s.* 10½*d.* per lb. The Queensland Crown Lands Act, 1860, offered a premium of £10 for three years, and £5 for the two succeeding years, for each 300-lb. bale of Sea Island cotton produced in the colony and exported to Great Britain. An additional incentive to cotton production at this stage was the high prices for cotton due to the American Civil War. In 1862, seventeen bales of cotton were exported. In 1870, 14,674 acres were planted with cotton and 1,630,755 lb. of lint were exported. In the following year 12,964 acres were planted and 2,602,100 lb. of lint were exported. With the resumption of normal conditions in America, and the consequent fall in cotton prices and the withdrawal of the Government subsidy, the area under cotton cultivation shrank considerably. A slight revival was manifested in 1890 through the establishment, with Government

assistance, of a cotton factory at Ipswich, in Queensland, but on the closing of the factory in 1897 these efforts were again relaxed.

Various samples of cotton produced in Queensland, New South Wales, and Western Australia have been received from time to time at the Imperial Institute, and the results of the examination of a number of these have been published in this BULLETIN (1917, 15, 23).

Factors Affecting Cotton Production

In connection with the activities directed in recent years to increasing the production of cotton within the Empire, the possibility of Australia proving a contributory factor has been apparently condemned on the erroneous assumption that "cotton is a black man's crop," and that the high cost of Australian labour must militate against its profitable production. The fallacy of this assumption is demonstrated by the United States Census returns, which show that three-fifths of the American cotton crop is produced by white men, and that two-thirds of the farms in the cotton belt are operated by them. Moreover, cotton farms operated by white owners produce the highest yields, and these are followed in order by those of white tenants, negro tenants, and negro owners. Labour is no more costly in Australia than in the United States, but, in any case, at the existing stage of the Australian cotton-growing industry, it would be inadvisable for the farmer to plant more cotton than he and his family can cultivate and pick unaided. Cotton must therefore be considered as an adjunct in diversified agriculture, rather than as the primary source of income.

Fortunately there are several other crops that can be successfully cultivated in Australia in conjunction with cotton, such as maize, tobacco, groundnut, lucerne, fruit, and grain sorghums. Other profitable occupations that may be pursued in association with cotton growing are dairying and pig and poultry raising; butter, cheese and bacon factories have been successfully established in many parts of Australia.

Thinning out the young plants and picking the crop

are the two most laborious tasks connected with cotton growing. It is probable that, as the industry develops and larger areas are grown, assistance for these operations may be procured from the large towns, as is done in the case of fruit picking in the irrigation settlements of the southern portion of the continent. Too much reliance must not, however, be attached to this source of supply, for the fruit and sugar industries already demand a considerable proportion of the casual labour available.

Overseas transport has been cited as an obstacle to profitable cotton production in Australia, but this does not appear to have unduly affected the marketing of Australia's staple products, such as meat, wool and wheat, while Australian fruit is successfully competing in the English market with that of countries situated in much closer proximity to these shores. It is significant in this connection that the Chamber of Shipping of the United Kingdom has in a recent statement emphasised the desirability of Australia substantially reducing her port and terminal charges, which hinder the cheap marketing of her produce. As an illustration it is mentioned that the costs of a cargo steamer of 11,000 tons remaining in port for five days are, in the United Kingdom, 55 to 62 per cent. over those ruling in 1913, while in Australia they are 148 per cent. higher. Terminal costs examined in detail show that light dues in Australia are 225 per cent. over pre-war rates; whereas those for the United Kingdom have now been reduced to only 14·3 per cent. above pre-war rates. Further, it is stated that shipping services to Australia are running at a loss; the Australian Government Line has shown a loss of £2,700,000 in the last two years; and that consequently it is in vain for Australia to hope for further reduced transport charges until she has substantially reduced her own port and other terminal charges.

Prospective Cotton Growing Areas

Such investigations as have been conducted up to the present indicate that the areas best adapted for cotton cultivation are to be found in Queensland; Northern

New South Wales; the Northern Territory; the irrigated districts of New South Wales, Victoria, and South Australia; and in North-West Australia. A glance at the map will demonstrate the fact that American cotton has to be transported by railway for export over far greater distances than would be necessary with respect to cotton grown in any of these States.

Queensland

Queensland appears to offer the best prospects for successful cotton cultivation, but, until the areas in the other States have been properly tested, it would be unwise to ex ress a dogmatic opinion on the subject. Soil and climatic conditions are most favourable in the belt extending from the southern border to Cape York, a distance of 1,300 miles, with a breadth of approximately 200 miles from the coast. At different periods, cotton has been grown at numerous centres throughout this belt in sufficient quantities to demonstrate the suitability of the soil and climate. To-day isolated plants may be found in these localities growing in a semi-wild state, and unfortunately are a menace to cultivated cotton, as they function as a nursery for pest propagation.

Land Tenure.—Within this belt there exist enormous areas of fertile virgin land lying idle in proximity to railways and shipping. Under the Queensland land laws, farm holdings can be obtained on a perpetual leasehold tenure, on payment of a rental to the Crown of about 1½ per cent. per annum on a moderate valuation of the land. The settler is thus not encumbered at the commencement of his operations with a weighty mortgage, and his capital is available for developing his holding.

Climate and Soil.—With respect to latitude, climate and soil, the conditions obtaining in the Queensland cotton-growing areas are somewhat similar to those of the American cotton belt. The Queensland areas are situated in 11°–29° south latitude. Along the northern boundary of the American cotton belt, the average summer temperature is 77° F., and along the southern boundary it is 80°–85° F. The mean summer temperatures are for

Central Queensland 80·5°, South-West Queensland 80·8°, North Queensland 81·2°, and North-West Queensland 84·3°. The average annual precipitation in the American cotton belt varies from 23 in. in Oklahoma and Texas to 55 in. in North Carolina and 60 in. in South Mississippi, but throughout much of the belt it is between 30 and 50 in. In Queensland it ranges between 25 and 120 in. The heaviest precipitation occurs in parts of North Queensland where sugar is extensively grown; elsewhere it ranges between 25 and 60 in. The growing season is of good length and favourable to cotton cultivation, for most of the rain falls in the summer months November to April.

The most productive cotton soils in the United States are the dark-coloured clay lands, and the red, brown and black river bottoms; the prevailing soils in Queensland are fertile decomposed basalt, diorite and alluvial loams. The deep rich volcanic loam soils of the Atherton tableland and other areas have been known to produce nine or ten consecutive crops of maize without the application of fertilisers. The average yield of maize on these soils is 45 bushels, of 56 lb., per acre, though as many as 100 bushels per acre have been recorded. The black clay loams found in certain marshy areas are, in their present condition, unsuited for cotton cultivation, but would probably be greatly improved by drainage and thorough working. The light porous sandy loams that are commonly met with are also unsatisfactory as they are lacking in organic matter and are unretentive of moisture; their fertility and physical condition would, however, be much improved by heavy dressings of organic manure.

Cultural Experiments Urgently Needed.—Hitherto cotton has only been grown in a spasmodic manner, and as the growers had little knowledge of the crop's requirements, it is not surprising that the results have not been very gratifying, and little reliable information is available as to crop yields and production costs. The following average costs per acre, on 22 acres planted in 1921, which were furnished to me by a farmer in South Queensland, are therefore of interest in this connection. I may mention that this was the best cultivated cotton farm that I saw

during my investigation of the Australian cotton-growing districts :

Expenditure.	£	s.	d.	*Receipts.*	£	s.	d.
Production . .	2	5	0	950 lb. of seed cotton at 5½d. per lb. . .	21	15	5
Picking at 1·6d. per lb. of seed-cotton . .	6	9	4				
Bags, pressing and transport . . .	0	16	0				
Interest on farm value	0	15	0				
	£10	5	4		£21	15	5

The high cost of picking is significant, for it absorbed more than 28 per cent. of the gross return.

Sea Island, Brazilian, Egyptian and Upland varieties of cotton have been casually tested. These have now all become hopelessly mixed together through cross-fertilisation in the field and lack of care in the process of ginning. This admixture has been still further intensified by the circumstance that growers have been advised to cultivate annual and perennial cottons in alternate rows, with a view to cutting out the annuals as the perennials increase in size.

Well-conducted experiments are urgently needed to determine the proper planting season, the best planting distances and, most important of all, the variety or varieties best adapted for cultivation in particular districts. Demonstration farms are also required to serve as object-lessons for inexperienced growers. In parts of Northern Queensland adjacent to the coast, where a long growing season obtains, it is most probable that Sea Island cotton of good quality could be grown; but elsewhere long-stapled Upland cotton, such as Durango and Allen, will probably prove most profitable. Pure seed of Durango cotton, that I was able to introduce by the courtesy of the Chief of the United States Bureau of Plant Industry, has already given promising results, and has produced lint of good quality and 1⅛ in. staple.

In view of the high costs of production, it is imperative that cotton of superior quality should be grown, especially as the same costs for ginning, handling, freight, insurance and marketing obtain for it as for inferior cotton. The necessity for better cultural methods is shown by the

circumstance that the average yield of seed-cotton per acre recorded up to 1921 was only 398 lb.

Insect Pests.—As in all other cotton-growing countries, insect pests are prevalent, but so far the Mexican cotton boll-weevil and the pink bollworm have not been recorded. Stringent measures are enforced by Government to prevent the introduction of new pests and diseases. The commonest insect pests of Queensland cotton fields are: bollworms: *Chloridea (Heliothis) obsoleta*, Hubn., *Earias Huegelii, Conogethesis (Dichrocrosis) punctiferalis*; stainers: *Dysdercus cingulatus, Oxycarenus luctuosus*; sucking bugs: *Tectacoris Banksii, Aphis* spp.

Assistance to Growers.—The State provides, free of charge, cotton seed for planting purposes, and has for several years given monetary advances to cotton growers in the form of a guaranteed price for seed-cotton delivered at the nearest railway station. Particulars of advances thus paid by the State, and other Queensland cotton crop statistics are given below:

Year.	Cotton acreage	Yield of seed-cotton. lb.	Guaranteed price paid to farmers. d.	Total cost of guaranty. £
1907	300	109,294	1½	683
1908	540	117,521	1½	704
1909	509	129,245	1½	808
1910	460	151,438	1½	946
1911	605	186,894	1½	1,168
1912	441	150,414	1½	940
1913	214	10,338	1½	64
1914	134	9,445	1·65	65
1915	72	11,363	2·537	120
1916	75	17,867	2·537	189
1917	133	118,229	3·58	1,764
1918	203	166,458	4·35	3,017
1919	73	37,238	5½	853
1920	166	45,581	5½	1,038
1921	1,967	922,778	5½	21,145
1922	7,000	3,755,526[1]	5½	86,064[1]

[1] *To the 31st August*, 1922.

It should be observed that the guaranteed price is paid on the understanding that any excess realised by the subsequent sale of the crop shall be divided *pro rata* among the growers. For the season ended July 31, 1923, the guaranteed price was 5½*d.* per lb. for seed-cotton of good quality, which is much higher than was warranted

by existing market quotations for cotton, as it requires rather more than 3 lb. of Queensland seed-cotton to produce 1 lb. of lint. The development of the Queensland cotton-growing industry in recent years is primarily due to the high prices that have been guaranteed to the growers for their crop, so that the industry exists at present on an unsound basis. The guarantee is limited to an area of 50 acres for any one farmer or company, and does not apply to ratoon cotton, but until the last-mentioned date 3*d.* per lb. was paid for this class of cotton, and after that date no ratoon cotton was to be accepted; indeed the Queensland Government is now prohibiting the cultivation of ratoon cotton. For the 1924 season the guaranteed price of 5½*d.* per lb. will only be paid for seed-cotton of 1⅛ in. staple, while a price of 4½*d.* per lb. is guaranteed for shorter-stapled cotton.

The British Cotton Growing Association has also rendered generous assistance to Queensland cotton growers. From January 1920, and for a period of five years, it guaranteed a price of 1*s.* 6*d.* per lb. of lint forwarded to them, freight and insurance paid, for sale in Liverpool. The Association's loss throughout the period was limited to £10,000, and this sum has already been exhausted.

Local Demand for Cotton.—During the war period no difficulty was experienced in disposing of the crop locally, as the usual supplies were not forthcoming from Asia. Latterly considerable supplies of raw cotton and its subsidiary products have been imported into Queensland, but in course of time this demand should be met from the local supply. The values of the imports in 1919–20 and 1920–21 were as follows:

	1919–20. Value. £.	1920–21. Value. £.
Raw cotton (lint)	55,307	24,781
Cotton wick	17,462	25,173
„ wool	12,465	27,117
„ seed oil	11,312	26,399
„ yarn	33,028	99,391
Other cotton products	91,254	282,757

No cotton spinning or weaving is at present carried on in Australia, but it is conceivable that the institution of these industries would readily absorb the whole, or at

any rate a considerable portion, of the local crop for some time to come.

Ginning.—Under agreement with the Government, a commercial company has erected ginneries at Brisbane and Rockhampton. The ginneries are equipped with American saw gins of the air blast type and presses which turn out the American type of bale weighing about 500 lb.

New South Wales

Cotton has been planted in a promiscuous manner in different parts of New South Wales during the last thirty years. Planting tests have shown the Northern portion to be well suited to cotton growing, especially the northern Rivers District. With the exception of the Upper North Coast, it is considered that the frostless season is too short except for Upland cotton. Sufficiently protracted experiments have not been conducted to determine the most suitable districts for cotton growing, the best varieties to grow, the yield per acre and cost of production.

Cotton yields obtained at the Yanco Experiment Farm in 1914–15 were as follows:

Variety.	Yield of seed-cotton per acre. lb.
Russell's Big Boll (Queensland seed)	620
,, ,, (local seed)	572
Allen's Long Staple	603
Sachiavilli	330
Durango	264

The cost of production per acre for a 600-lb. yield of seed-cotton, with man labour at 9*s.* 8*d.* per day, was £8 2*s.* 4*d.*, including £3 12*s.* 6*d.* for picking. The average quantity of seed-cotton picked per day of eight hours was 80 lb.

In this State the Government is guaranteeing prices for seed-cotton, delivered at the ginneries, of 5¼*d.*, 4¾*d.*, and 4*d.* per lb. for the first, second and third year respectively.

The Northern Territory

Cotton grows in a semi-wild state in many parts of the Northern Territory, but here also experimental work will have to be carried out in order to decide whether the crop can be profitably grown on a commercial scale.

The Irrigation Settlements

In the irrigation settlements of Victoria, New South Wales and South Australia the agricultural conditions are similar in many respects to those that obtain in the irrigated south-west of the United States, where cotton of an Egyptian type is produced under the name of Pima cotton. These settlements are at present confined to the valley of the river Murray and its tributaries, where there are some 130,000 acres under irrigation. The Federal and State Governments purpose spending up to £5,000,000 in locking the river and providing storages for extensive irrigation schemes adjacent to the river and transport. When these schemes are completed it is estimated that 2,000,000 acres will be available. The Murray has been described as the Australian Nile. Together with its tributaries, it has a navigable length of 3,212 miles, and the irrigable lands in the vicinity of their banks are of an enormous extent, for they drain a basin of 414,000 square miles. As in the case of the Blue Nile, the Murray's principal tributary, the Darling, carries down rich alluvial deposits and enriches the lower lands. The sandy loams of the river banks are thus exceedingly fertile, and are reported to have a population of one person for every two cultivated acres.

In the fruit-growing section of the Californian irrigation districts, Pima and other long-stapled cotton is grown as a subsistence crop while the farmer is waiting for his fruit trees to come into bearing, and it is considered that a similar plan could be usefully adopted in the Australian irrigation settlements, where cotton growing could be undertaken by the farmer without additional expense. In the irrigated south-west of America a medium sandy loam is looked upon as the ideal type of soil for cotton cultivation, and this is the predominating soil in the Australian irrigation settlements. Lucerne is one of the staple crops in both places, and is generally recognised as one of the best rotation crops to grow with cotton under similar conditions.

Pima cotton seed, which I introduced, by the courtesy of the Chief of the United States Bureau of Plant Industry, is reported to have given satisfactory results.

Western Australia

Cotton of good quality has been grown in Western Australia and especially in the north-western portion of the State, where in certain districts the soil and climatic conditions resemble those prevailing in the Queensland cotton-growing areas, but properly conducted cultural tests are required to determine whether it can be profitably grown on a commercial scale.

Labour is scarcer in North-West Australia than in other parts of the Commonwealth, but the possibility of employing aboriginal labour merits consideration where the climatic conditions are too trying for whites. It is estimated that there is an aboriginal population of 25,000 as against a population of only 6,000 whites.

Summary

The soil and climatic conditions in large portions of Queensland, Northern New South Wales, North-West Australia, the Irrigation Settlements, and probably also in the Northern Territory, are well adapted for cotton cultivation, but properly conducted experiments will have to be carried out to decide whether the crop can be profitably grown on a commercial scale, and to determine the best planting season and the variety or varieties that are best adapted for cultivation in particular districts. Careful seed selection of approved varieties will have to be practised, and the seed supply strictly controlled in order to prevent varietal mixture.

GENERAL ARTICLE

THE CULTIVATION OF BLACK WATTLE

Black Wattle (*Acacia mollissima*) is largely grown in Natal and Kenya Colony as a source of tanning bark, and the question of introducing it into a number of other countries of the Empire is being considered. Reference to the Natal industry, particularly from the standpoint of the local manufacture of wattle bark extract, has been made from time to time in this Bulletin and accounts

have been given of the possibility of utilising the spent bark for paper making and the wood for the manufacture of acetic acid, acetone, charcoal and other products by destructive distillation. The following are the principal articles dealing with wattle bark: "Production and Utilisation of Wattle Bark," 1908, **6**, 157; "Wattle Barks from the Transvaal and the East Africa Protectorate," 1910, **8**, 245; "The Utilisation of Wattle Bark," 1911, **9**, 116; "Black Wattle Bark from the East Africa Protectorate," 1913, **11**, 402; "Destructive Distillation Trials with Black Wattle Wood," 1916, **14**, 570; "The Wattle-bark Industry of Natal," 1916, **14**, 599; "Wattle Bark and Wood" (paper-making trials), 1917, **15**, 496; "Black Wattle Wood Ash from the East Africa Protectorate," 1919, **17**, 281; "Wattle Bark from Ceylon," 1923, **21**, 466.

The following information relating to the cultivation of the tree and the preparation of the bark is taken from an article on "The Black Wattle Industry," by Dr. T. R. Sim, which appeared in the *South African Journal of Industries* for October and November 1922, and January 1923.

Climatic and Soil Conditions

There used to be a widespread belief that, in Natal, scarcely any selection was required for the site of a black wattle plantation. No greater mistake ever was made, and it is now definitely known that black wattle has its requirements, which must be met if the best results are to be attained.

There are sites, soils, subsoils, aspects, climates, and conditions, often difficult to define, but quite recognisable, and often intermixed or overlapping, in which the tree does not succeed satisfactorily; while even in the best it shows unaccountable variations in product, which can hardly be foreseen by even a most skilled cultivator.

Rainfall.—A rainfall of 30 to 40 inches per annum is most suitable. A rainfall of even 20 inches will do if the soil is deep and porous; but, while a continuously misty atmosphere is very favourable, the rainfall itself is immaterial if moisture is otherwise available, as around a

spring or along the course of a river; indeed, it has been proved at Worcester, in the western part of Cape Province, that the tree can be grown successfully in extremely arid conditions by means of irrigation. In any case the water must be fresh and sweet, as stagnant moisture is very injurious, especially during the first years. It has been estimated that a plantation of mature black wattle transpires regularly an amount of moisture equal to about 40 inches of rainfall in the ordinary temperatures of the Natal midlands: consequently, if the supply of moisture from all sources is less than that, the plantation will eventually dry out the ground and suffer; whereas, if the supply is too heavy, the trees may become lichen-clad to an undesirable extent and otherwise suffer.

Like blue gum (*Eucalyptus globulus*) the black wattle can be used for drying up swamps, but is more difficult to start on account of vegetation, the gum transplants usually coming on more rapidly than black wattle seedlings. If, however, it germinates and grows satisfactorily, it is as effective in its action afterwards as any other tree; indeed, so absorptive is it, and so widespreading its root, that few trees survive intermixed with black wattle, and cases have been known where wattle started from self-sown seed washed by floods on to ground where gums had previously been successful absorbed all the surface moisture and prevented the gums from obtaining what they required at a lower depth; whereupon the gums died from drought while the wattles continued to prosper on the surface moisture.

Temperature.—Altitude alone is not so decisive a factor as many believe; it usually affects wattle only in so far as it is responsible for frost or heat. Thus, if the altitude be low, the temperature is too high, and the condition of "thorn-veld" or of "sweet veld" is more likely to be present; on the other hand, if the altitude is too high, there is a danger of reaching the frost limit, and also a danger of coming into country which, apart from frost, is too bleak for wattle culture.

The frost limit is a curiously distributed factor, affecting wattles mostly during their first or second year of growth, and as low valleys are more subject to frost than the

adjoining high flats, it usually happens that the wattles in these valleys are more affected by frost than others are on the highlands, though the latter be in a much more exposed and bleak situation. The bleak localities do not come into any commercial wattle culture, but the results mentioned above can be seen abundantly in such localities as the Transvaal high veld, portions of the eastern Free State, and even in portions of the eastern Cape Province. Frosty valleys adjoining good wattle lands are to be found at an altitude of less than 3,000 ft. in the Transvaal bush veld, and, again, wattles doing well even under very severe exposure are to be found up to 6,000 ft. in the Natal highlands, though overlooking much lower frosty localities where they fail. The higher altitudes are more favourable in respect to pests, but at the same time are often more subject to hail, snow, wind, and other destructive weather influences.

Soil.—Suitable soil is as essential as moisture supply, and there are certain classes of soil which are much more satisfactory than others. The deep red or chocolate soil produced by the disintegration of dolerite is the soil on which wattles naturally do best and this is almost invariably connected with misty conditions and with sour or mountain veld.

The physical condition of the soil is of much more importance than its chemical composition, and the usual experience is that any sweet veld having compact soil, with some admixture of lime, is unsuitable.

On light sandy soils the tree is sometimes satisfactory if the depth is sufficient, but, where depth is absent, it is usually less satisfactory, and it is this condition of soil which has produced so large an area of unsatisfactory wattles in localities where the climate appears to be fit.

The presence of oudeklip or of umqubane as subsoil is always deleterious, and soils overlying this, without much depth, should never be used; while the presence of sandstone rock is very unsatisfactory, especially in cases where that rock has formerly been under igneous rock that has since weathered away and left the sandstone indurated and impervious.

The idea that ground which is sufficiently deep to

grow first-class maize is also suitable for first-class wattles is usually fallacious. The maize plant enjoys a hot soil of no great depth, sufficiently moist during the growing period to carry the crop, and at other times not necessarily moist at all, which conditions are unsuitable for black wattle culture, as the latter prefers cooler, deeper soil, and constant humidity.

Deep black alluvial soil is quite suitable, but in South Africa usually occurs where frost is liable to interfere, and also is often subject to more trouble from weeds during the early stages of a crop than the more porous ground already referred to. If it is overlying stiff clay, it is much less suitable ; and clay itself, as surface soil, is altogether unsuitable, as are also some soils that are often more or less compact in nature. The results here depend partly on the nature of the shale and its surface soil, and partly on the treatment which that receives. Solid shale at or near the surface is never satisfactory, but an occasional outcrop of open yellow shale through which the roots can pass is quite admissible ; the result usually is that, the more shale there is present, the smaller are the trees at any given age, but shale is not altogether excluded as a soil which is fit to carry a profitable wattle crop.

Shale itself is, of course, to be regarded with suspicion, and the farther it is away the better will the wattle do.

Generally speaking, the good wattle country in Natal corresponds very closely with the yellow-wood belt, including suitable areas over fifteen and under seventy miles from the sea, right through Natal and Zululand with occasional outlying arms along the foothills of the Drakensberg, but not including any part of what is known as "thornveld," in which class of country wattle culture is usually doubtful. This excludes most of the coast belt, the valleys of the large rivers, and practically all country in which "thornveld" predominates, and it is quite clear that black wattle and "thornveld" are never both satisfactory on the same ground.

Preparation for Sowing

Although during the first few years of wattle culture many experiments were made to ascertain whether it

was not advisable to plant black wattle transplants in the same way as gum transplants are planted, on account of the seeds germinating badly if sown untreated, it was soon discovered that sowing the seeds *in situ* after treatment was the only commercial method of starting a plantation, and for this it was necessary to plough well in order to get the ground into good condition.

Many mistakes were made in supposing that cultivated land was more easily prepared and consequently more suitable than land which had never been broken up before. It is now found without doubt that unbroken land gives better germination and growth than cultivated land, especially if the latter has been badly cultivated as, for instance, in native maize patches. The reason for this is difficult to explain ; it may be that the bacteria required by the black wattle are killed by cereal cultivation, or, on the other hand, it may be that the ground is rendered poor and that the crop of weeds is regularly large on what has been cultivated land. The fact remains that new land broken up specially for the crop is the best and the least expensive preparation.

The time of the year at which this work can be done varies considerably with the locality and the season. Anything done in the Western Province, where summer rainfall prevails, must necessarily have the treatment adapted for the rainfall, but the area of black wattle in the Western Province is very small and likely to continue so, while the commercial output comes from Natal and its neighbours. In these latter districts summer ploughing is the best, but it must be sufficiently late to prevent the growth of red grass. It is advisable to plough in such a way that the red grass should be completely rotted in the process, or else that it will be killed by drought through standing in the sods during the following winter. The more thorough the ploughing, the more satisfactory will be the crop.

It is advisable at any season of the year to have the grass burned off before ploughing is done. Burning prevents a regrowth from the long tops of the grasses ; and, indeed, where burning is not done it often happens that the roots are ploughed under but that long growing

stems which are left act as suckers and produce large grass-plants in a very short time. Burning, however, has probably also an after-effect in connection with the bacteria produced on the wattle roots, which regularly collect and store nitrogen to such an extent that the land is thereby improved for maize and other cereals after the wattle crop has been removed.

The ploughing should be as thorough as it is possible to make it, as the result shows beneficially throughout the whole rotation of the first crop, and again acts beneficially when renewal is in process.

Sowing may be done at once upon freshly turned soil fairly early in the autumn, or at any later stage during autumn which is not subject to severe frost, or the ground prepared in autumn may not be sown until spring, as is quite frequently the case. The result is usually better from autumn sowing, since in that case the plants germinate, but remain small and prostrate during the first winter and are thereby free from frosts, whereas if sown in spring the trees are more or less vigorous and often grow to the height of one to several feet before autumn, and are then in a condition in which frost affects them readily.

Some growers claim that it is worth while applying fertilisers to the ground which is to be sown with wattle. It is certainly the case that wattle trees growing uninvited in gardens or in rich localities develop with enormous vigour. On the other hand, it is also the case that if an old cattle kraal is situated in a plantation the wattle trees there almost invariably die, apparently from over-manuring. Dr. Sim's own experience leads him to believe that the application of ordinary complete fertiliser can be made with profit. This is seen where ground hardly fit to carry maize is well fertilised on purpose to obtain a catch crop of maize between the rows of wattles during their first summer. Such catch crops usually pay for the labour and manure, and the wattles undoubtedly benefit from the residual manure and from cultivation unavoidable for the maize. The whole question of catch crops, however, is dealt with further on.

Sowing

Wattle seed, on account of its very hard coat, needs special treatment before sowing. If mature seed is sown in the usual way, it usually remains lying in the ground for many years, still fit to germinate, but only a few seeds germinate until propitious conditions come along.

For sowing in plantations, it has been found advisable to soak the seed in boiling water, or even partly to boil the seeds if they are of considerable age. The usual method of doing this is to take a five-gallon paraffin tin full of water, bring it to boiling point, then immerse all the wattle seed that can be got into it. The tin is left thus until the water is cold, when the seed will usually be found to have absorbed the water, swollen a good deal, and become soft enough to be cut by the finger-nail if squeezed between the finger and thumb. Sometimes a second or even a third treatment is necessary before the seed is in the right condition.

The next thing is to make the seed fit to sow, which, on account of the gelatinous condition produced in the water, is sometimes difficult to secure. For this, a slight mixing of dry fine sand answers, and if the seeds are rubbed among this they become dry enough again to be easily separated in the sowing process.

It is important to note that, after germination has once been started under the above process, it must be allowed to continue ; the seeds must be sown immediately after being washed or mixed with dry sand, and then covered with soil without delay. If the seeds after soaking are left exposed to dry wind for a day, the germ runs the risk of being killed ; if sown on ground too dry to maintain germination, there is the same danger ; and if held over in the tin or bag for a few days after being germinated, they are apt to heat and sprout very rapidly, and become too tender for sowing. More blanks occur, however, through insufficient soaking than from all other causes.

Needless to say, then, the ground must be ready for the sowing to be proceeded with directly the soaking process is completed. The condition of the land surface should be very much the same as for a cereal crop. If well

harrowed down, it is in its best condition, but harrowing should never be up and down hill, but should always contour the hill if there be one, so as to avoid the chance of washaways through rain.

Old-time practice favoured sowing the seeds broadcast at the rate of 5 lb. to 10 lb. per acre, so as to secure abundant germination, which could be reduced by hoeing to the necessary quantity, but modern practice has departed from broadcast sowing, and even from sowing in continuous lines which at one time was in common vogue, and now the seeds are usually sown in small pits, just where they are intended to grow. Machine sowing has not yet come into general use, although several growers have tried sowing machines intended for other purposes but adapted for black wattle seed.

The practice in Natal is, however, to sow in orderly lines, which are neat and business-like, and are useful in felling and in regrowth. Where a maize crop is not taken, the rows are usually arranged by placing stakes in line at short distances so that several are in sight at once. A coolie then proceeds from one stake to the next, keeping the line of stakes in sight, and with a hoe prepares small seed-beds in slight depressions at the determined distance apart, which ranges from one to three paces. Another coolie follows and drops about a dozen seeds into each seed-bed, covering them slightly with his foot. The guide-stakes are then moved forward to be ready for the next line.

The seeds must not be buried too deeply. The depth should never exceed half an inch ; even less than that is sure to give good germination ; and the seed-pit itself should not be deep in the ground, or there is a danger of rain washing in so much soil as to bury seeds after they are sown.

If possible the soil should be in moist condition when the sowing is done, that is to say, advantage should be taken of the time immediately following a shower, or even of the days following a heavier rain, in which latter case the soil continues damp until germination takes place, which happens within a week or ten days if all goes well.

Care should be taken to sow all the seed at the same depth, in order to avoid irregular germination. Resowing is always a difficult process and is usually less successful, while if there are blanks remaining for several months, it seldom happens that these can be separately filled up with trees which will continue to keep pace with their older neighbours.

The amount of the seed to be sown varies with the ground and the method of sowing. The less used, so long as there is a sufficient crop, the less labour will there be in thinning, but it must be remembered that it is much easier to thin out than to fill in after the crop has germinated. The general practice is sowing in lines, and 1 lb. to 1½ lb. of seed is used per acre. On dry or lumpy ground more seed is required than when the seed-bed is fine, and so sowing is usually done on freshly broken-up ground, harrowed fine, without much other preparation.

Thinning should be done as soon as the seedlings are fit to handle easily, say when 6 in. to 12 in. high, and is best performed by hand, as in hoeing many plants start again from below if cut near the crown. If locusts are about, or likely to be about, it is better to leave too many plants than to thin to the exact crop.

Espacement and Rotation

Every grower has his own ideas about espacement, and practice varies more on this subject than on any other. No definite rule can be laid down, since soils differ remarkably within a few yards, and common sense must be exercised with regard to every farm and every acre on that farm. The espacement used commonly to be 6 ft. by 6 ft., and sometimes even closer, but to-day it is recognised that a wider distance gives a better return in the same period, and since there has also been a tendency to make the period longer, it is quite common practice now to sow the lines as far apart as 12 ft. and the plants 6 ft. apart in the line.

Although the closer plantation gives straight light poles and sometimes more height, the wider espacement makes up for that by giving straight poles of larger size

in any given period, since each tree carries more foliage and is fit to supply its stem with more nutriment than those in any closer plantation. The duration of the rotation used to be regularly six or seven years, but in many cases that meant felling before the trees had attained heavy bark—while the bark was still in what is known as the "baby" stage—while the longer period allowed the production, within another year or two, of much heavier bark and timber, with a larger output and a greater return per acre for the short extra period required. The rotation now varies from seven to twelve years; in most localities the bark is still good when it is twelve years of age (except on trees standing singly), and its product is then twice that it would have been in the shorter rotation, and the timber produced is changed from firewood into useful mining timber. Most advanced farmers who can afford the longer period prefer it. It used to be the practice to thin only after the thinnings were of value, which was at four or five years of age; now the practice usually is to thin out all the weak trees as soon as they show that condition, say at two years of age, even though it costs something to do it and brings nothing in return. The crop may be brought down by thinning to less than half its original stand and still be improved by that process, as larger trees manage to make increment much more rapidly when they have enough space in which to grow.

Cultivation is now regularly resorted to, and is considered necessary in all circumstances until the trees are large enough to keep the weeds down. The earlier practice was to sow and leave the weeds and wattles to come along together, and the wattles were expected eventually to find their way through and to dominate. Frequently a year was lost in doing so, which represents a greater financial loss than the cost of the cleaning. The espacement should be greater on first-rate land than on poor land, since the finest trees are produced on the former, while the latter can produce second-rate trees only, and must have more of them per acre if anything like an equal return is to be obtained.

Pruning

Some of the best growers recognise the advantages of pruning a crop which is not quite equal—that is to say, where some trees have gone far ahead of the others. These can with advantage be pruned back equal with the others since the danger of producing dominating trees is thereby removed. Many growers never do anything in this direction, and lose average weight accordingly, since the bark obtained from each large tree is not equal to what is obtained from a large number of somewhat smaller trees which would have occupied that ground had a dominating tree not been there. On the other hand, the practice of pruning trees from the base upward carries no advantage with it, and is so much labour lost. The most important point in pruning, however, is to remove any competitive leaders so that each tree may have only one stem left growing on to maturity. This is not done by cutting away the whole competitive stem as might be supposed, but rather by breaking off the point in the competitive stem which seems to be making trouble. If, instead of doing that, the branch were cut clean off, the probability is that a new shoot or several young shoots might start into growth and again become competitors.

Pruning is also necessary sometimes in connection with insect pests (see p. 624).

Felling

Thinning hardly comes under the head of felling, although it leads the way up to it. Each thinning is partial felling, and in calculating the total result each thinning should be taken into account. But small material, though its removal is necessary, costs more to strip than does matured material, and brings little or nothing.

The season at which thinning should be done varies in different localities. It is advisable to thin while the sap is up so as to secure easy removal of the bark, but it is also advisable to fell at the season when drying can be done without danger from rain. Newly felled bark can stand a shower without deterioration, especially if it is

hanging in such a position that the water will run off, but if bark has been half-dried and then becomes subject to days of continuous rain, it is apt to become mouldy, suffering in quality and in value.

Felling is usually done by estate hands on task, in which case the man rises and starts work as early as he likes in the morning, and leaves off as soon as he thinks he has done enough for the day, and also he may be assisted by his wife and children, the one requirement being that he produces sufficient green bark to represent one or more days' task. In this way some men have a few days to spare at the end of the month and can take them as extra holiday. Other workers seldom come up to the task requirement. Where the crop is good and the bark is peeling off easily, 1,000 lb. of green bark per day is quite a reasonable task ; during the dry time and when the trees are stripping badly, 500 lb. may be an excessive task, so a good deal of the profit or loss lies in economic handling by felling at the season when the largest return can be had for a day's labour. It is also necessary to draw a distinction in regard to task between trees which have reached a large size and have matured bark, and trees of small size which have bark in the " baby " condition.

Drying

If the felling can be done at a time suitable for both barking well and drying well, no sheds are necessary ; but it is often the case, and especially where large quantities are being handled, that sheds are an absolute necessity to protect bark when rain happens to fall. The class of shed varies, but in most cases it is the practice either to hang the bark, up where the trees are being felled, on some trees left for that purpose, or else to arrange lines of wattle branches in such a way that the bark can be spread upon them until the first drying is done. In either case it is advisable that no portion of the under-surface be exposed to the sun, since that is apt to bring about discoloration. Sometimes all the drying that is required can be done in this way, but it more frequently happens

that the weather changes and if half dried bark has to be removed to the sheds, it is usual to bundle the bark where it was first half-dried, and then to unpack it at the shed and hang it up across poles, which are so arranged that they can be removed from place to place without difficulty, even while the crop is hanging upon them, until drying is completed. On some estates these pole-yards are arranged under an iron roof in such a way that the cross-poles carrying the crop can be moved out into the open air as soon as the weather is favourable, and again brought in when it is unfavourable; but on other estates the poles are fixtures, and the crop remains hanging there until it is finally dried.

When completely dry the bark is subjected to one or other of the processes by which it is made fit for railing to the mill or factory, unless there happens to be a mill on the farm, in which case it is taken there direct. Up till about the time the war began almost all bark was shipped to Antwerp, either in bales of bark about 4 ft. long, or chopped up and packed into bags containing 1¼ to 2 cwt. The space taken by the bundled bark naturally costs a great deal more than that taken by compressed bundles or by bags, consequently many devices were brought into use whereby the bark packed into a given space could be increased. Rotary packers, having stamp action, managed to pack into bags nearly twice the weight that could be put into them without these packers; but a further improvement was the process of packing into cubes by hydraulic pressure, which was found to suit the circumstances, inasmuch as no space was left between the cubes when packed in the ship, and at the same time the bark was packed as compactly as could possibly be done. This process is still in use, all the bark being chopped into pieces 1 in. or 2 in. long to suit this packing. There is also another process in use whereby the bark is shredded and then subjected to a similar packing process under hydraulic pressure.

The packing on the larger estates is usually done upon the estate, but in the case of the smaller estates central packing-houses usually clear the crop from several estates. At these central packing-houses bark is usually bought

as rough stick bark delivered from wagons, and is sent away as compressed cubes fit for shipment.

Yield of Bark

Since every locality has a different production, and since the method of culture affects the output considerably, and also since climatic conditions have had an enormous effect upon the crop production, it becomes evident that no definite figures can be given as to the average returns per acre. Generally, for a seven-year crop 4 tons of bark and 20 tons of timber may be looked upon as a good crop ; indeed, in many localities crops of half that size have been worked with profit, but when longer rotation is adopted with the resulting heavier mining props and heavier bark, double the weights mentioned can be obtained at ten or twelve years of age with greater values per ton than in the previous case.

The whole cultural process requires watching from the time the seed is sown until the crop is harvested ; and the amount of crop taken often varies very much in accordance with the treatment.

When the man who is in charge of the plantation watches and takes advantage of every method by which profit can be obtained, his results are likely to prove much higher than those which the same ground would yield under negligent treatment ; it is so in regard to everything in connection with wattle culture, and all experience advises having the best man obtainable in charge of the work, whatever his cost.

Intercropping

It has already been mentioned that intercropping with maize can sometimes be done with advantage. This, however, is not usually the case since the maize requires a hot compact soil, whereas the wattle requires a cool porous one, and the wattle soil is generally too poor to carry a satisfactory crop of maize. It has, however, been found that a sufficiently good manure to ensure a crop of maize on wattle land has also a highly beneficial residual effect on the wattles during the first few years of the growth ; and,

since growth at that period helps largely to [illegible] good crop, the manure not only pays its way on the [illegible] but also upon the wattles themselves. Manure for wattles alone, without intercropping, has never been tried, except experimentally at Cedara, and that experiment proved nothing. Experiments in reference to the value of bark produced on different parts of the tree or upon trees of different age and espacement and from different soils, were conducted at Cedara by Mr. Williams, who has issued useful pamphlets upon that subject. Reference may also be made to Dr. Sim's paper on "The Black Wattle Industry," in *The South African Journal of Science*, February 1917, which contains information on many other subjects connected with the growing of black wattle.

The results of these experiments mostly tended to show that it is worth while separating thick bark from thinner bark while the felling process is in hand, so that they may be marketed separately and in accordance with their respective values.

Recropping

The usual practice in recropping is to burn whatever branches and other refuse are left upon the ground, so as to secure not only a suitable nidus, but also abundant germination of the seeds lying in the ground. Often it happens that there are not enough branches to burn equally over the whole area, and in that case the branches are packed into lines at the distance apart at which the lines of trees are intended to stand, and are then burned, leaving intermediate spaces which, without burning, are less productive of plants, and are more easily kept clean. The endeavour, however, in every case is to secure an abundance of plants; and if after germination there is found to be a shortage anywhere, that must be remedied without delay by sowing where the lines are intended to stand. The hoe is then freely used, leaving young trees only in the lines, and all between these lines is cleaned out. If the trees are left until a few inches high, then hoeing should again take place, leaving only the trees that are intended to remain permanently; and if blanks still remain these must be filled up either by transplanting neigh-

[illegible] plants or by again sowing seeds. No further treatment is required until the trees are fit for thinning, although it often happens that regrowth not handled early enough requires many successive thinnings to bring the crop into what may be considered good condition.

The length of rotation is in accordance with the owners' convenience and desire, and it is found that on thoroughly well-managed estates the second, third, and fourth crops continue to be as good as the first one or sometimes even better, but on badly managed estates, and especially where weeds or superabundant trees are left too long, the succeeding crops are not equal to the first.

Pests

It is rather curious that the wattle, which has been imported only by seed and probably never by plants, should be subject to many pests, since that method of importing is not likely to bring with it the pests of Australia. The black wattle, as an acacia, has many relations indigenous in South Africa, and pests which trouble them have taken possession of the black wattle and have adopted it as a host, or rather the black wattle has adopted them; and black wattle being grown in proximity as pure forest, and having shoots more constantly tender in growth, the pests have proved more destructive on this tree than on the native hosts. The bagworm is the worst of these, for it occurs wherever "thorn trees" grow, and consequently is always prepared to attack the black wattle there, but it also makes itself at home on apple trees and many others which extend into the wattle veld, and so is therefore usually present wherever wattles are grown. Fuller (*Union Agricultural Journal*, June, July, August, 1913) deals exhaustively with bagworm, and suggests shelter as a means of prevention, the shelter trees being so placed as to prevent the young bagworms, which hang upon a silken thread, from being blown from one area to another. Not much has yet been done in the way of testing the efficacy of this suggestion, for the bagworm is affected largely by climatic conditions and almost disappears during a season of continued rainfall.

There is also a fungus that affects the bagworm, and which shows its greatest activity when rain is abundant. In this way some plantations have been practically cleared of bagworm, but in the hot and dry localities which verge upon the "thorn-veld" there is always a sufficient number of bagworms left to make the pest superabundant again within a short period. When superabundant the result is that all the leaves are eaten off the trees, and usually one season is entirely lost, sometimes even two or three seasons in succession; and the trees not only lose all vigour but get into a bark-bound condition, from which they seldom completely recover.

Another pest is known as the wattle "froghopper," and though this name is a misnomer, the damage done to young trees is very serious indeed. The insect itself is unknown to most wattle growers, but the damage soon shows itself, inasmuch as small bundles of small unsatisfactory twigs are produced, closely resembling the condition known as witches' broom which affects many other trees. In this case, however, all branches are usually affected more or less, and become weak and small. The treatment which has been found best is to prune the trees severely so that almost all the sap is sent into one or two leading branches, which, given sufficient encouragement, sometimes get ahead and produce good clean leaders.

Another trouble, of a different nature and probably bacterial or physiological in its origin, is what is known as "mottle disease" of the black wattle. This has been carefully investigated by Dr. Van der Bijl, and his report issued in 1914 as *Science Bulletin* No. 4, *Division of Botany, Union Department of Agriculture*, contains much of interest which may eventually assist in preventive or curative treatment.

Various large caterpillars affect the native acacia trees, and frequently become a pest upon the black wattle, but generally the damage done by these is not serious, nor is it continuous year after year. The annual reports of the Entomological Department contain many articles concerning wattle pests, mostly by Fuller, and several reports elsewhere by Hardenberg are worth study.

Wattle Timber

For many years the timber of the black wattle was looked upon as a waste product, and was used as firewood in all localities close to the market, whilst in all localities distant from the market it was burned in order to clear the ground. But a change has occurred in connection with this, and now in all suitable localities the trees are grown on a longer rotation. This allows the timber to become prop size rather than firewood size, and the industry of supplying mine props to Johannesburg has become a very large one. The larger the trees are, the better do the props answer, and at the same time the trees produce thick bark of much more weight. Although this process requires more time, it is found to be more remunerative than the older one of cutting down trees at seven years of age irrespective of size and of the thickness of the bark. The demand for wattle firewood has increased enormously, especially in up-country districts where fuel is scarce and where large quantities can be absorbed. Wattle fencing droppers are also much more in use than in former years. They are usually from 1 to 2 in. in diameter and of ordinary fence height, and are not intended to be put into the ground, but simply to keep the wires at regular distances apart.

In the ground, wattle poles are not very satisfactory, as their period of fitness is comparatively short, and, although they are often used, they are found to be a comparatively dear means of fencing. Wattle timber is also used for many other purposes, such as gates, tent poles, yokes, keys, etc., and to a very considerable extent for the manufacture of fruit and potato boxes, but it has the disadvantage that the timber splits unless holes are bored for nails.

To a small extent charcoal has been made, and this practice might be extended on the remote farms, as its transport to rail is less than that of the same value of timber.

But allowing that the estimate of 160,000 acres now growing in Natal is correct, and that each acre when mature will yield 20 tons of timber in eight years, and

that half the total is too remote from rail to allow of marketing as fuel or otherwise, then we find that there are 200,000 tons of timber being burned as waste every year, besides what may be burned on farms nearer the railway. This quantity is, of course, scattered over a wide area, but the total is sufficiently large to place before the chemist and the Government as a problem worthy of investigation, with a view to distillation or any other use which may be suggested ; anything, in fact, rather than waste.

NOTES

Imperial Institute Committee of Enquiry.—The Report of the Committee of Enquiry appointed by the Duke of Devonshire, Secretary of State for the Colonies (see this BULLETIN, 1923, **21**, 363, 490) has now been published as a parliamentary paper (Cmd. 1997), and its principal conclusions and recommendations are summarised below. The Committee after reviewing the history and the financial position of the Institute, discuss its functions and operations and deal with the question of the relation of the Institute to other bodies, especially the Imperial Mineral Resources Bureau, and make recommendations as to its future work and management.

The opinion is expressed that the most essential function of the Institute is that of a Clearing House for collecting and disseminating information, and for conducting through the appropriate scientific, technical, and commercial organisations, enquiries and investigations regarding the raw materials of the Empire. The work of preliminary analysis and technical investigation of raw materials carried on in the laboratories is regarded as being almost as important, and it is recommended that it should be continued. It is also considered that the Advisory Technical Committees of the Institute are doing useful work in conducting special enquiries and investigations into specific raw materials, *e.g.* silk, timbers and rubber, and it is suggested that this work should be extended.

The Committee recommend that the Institute should no longer maintain Exhibition Galleries for illustrating the natural resources of the Empire, but that a representative selection of Empire products should be made for the purpose of a travelling exhibition of a purely educational character, and that the possibility of organising

travelling exhibitions of the staple products of the Colonies and Protectorates in the appropriate trade centres should be considered. The Institute should, however, continue to function at South Kensington as a Clearing House of Intelligence and Information, equipped with laboratories to enable it to carry on the work of preliminary analysis and investigation of raw materials. All enquiries entailing elaborate investigation or purely scientific research should be referred to the competent authorities. Reliable up-to-date sample rooms, illustrative of important Empire raw materials, should be maintained.

The Committee recommend that after the reforms in the management of the Institute referred to below have been carried out, the Imperial Mineral Resources Bureau should be amalgamated with the Imperial Institute. It is considered that the annual expenditure of the reconstituted Institute should be in the neighbourhood of £40,000 per annum. According to a memorandum by the Secretary of State for the Colonies appended to the Report, H.M. Government are prepared to propose to Parliament an annual grant of £9,000 a year for a period of five years and to invite the Colonies and Protectorates to agree to contribute between them an annual sum of £8,000 for the same period, on condition that the Governments of the Dominions and India are willing to give assurances that they will make contributions amounting in all to £8,000 for the fixed period of five years. The remainder of the annual revenue should be obtained mainly from the rent of the Exhibition Galleries and from the Endowment Fund of the Institute.

In the event of this scheme failing through lack of support from the Overseas Governments the Committee suggest an alternative scheme under which the Institute could, from its own resources, continue to carry on only what are regarded as its most essential functions, *i.e.* those of an intelligence and information bureau without laboratories.

The Committee recommend that the present Executive Council of the Institute should be abolished and that its place should be taken by a Governing Body containing representatives of scientific institutions, of trade and commerce, and of various Government Departments, as well as the Dominion High Commissioners or their nominees; and that the Director of the reformed Institute should be a purely administrative officer and should no longer be a member of the Governing Body or of the Managing Committee.

The Committee of Enquiry express their warm appre-

ciation of Professor Dunstan's prolonged and valuable services to the Institute and the Empire during the long period he has been connected with the Institute, and state that much of the valuable work that the Institute has performed during that period has been due in large measure to his energy and ability and to the knowledge and experience he possesses of the various types of technical work in which it has been engaged.

The Report of the Committee was submitted to the Imperial Economic Conference, which recommended the adoption of the first of the two schemes for the future of the Institute, subject to modification in certain details.

Resignation of the Director.—In view of the intended reconstitution of the Institute, Professor Wyndham R. Dunstan, C.M.G., LL.D., F.R.S., who was appointed Director of the Scientific and Technical Department of the Institute in 1896 and succeeded the late Sir Frederick Abel as Director of the Institute in 1903, has resigned.

Apart from the activities relating to his position as Director of the Institute, Professor Dunstan has assisted in other ways in furthering the development of the resources of the Empire, especially with reference to cotton-growing and rubber production. He has visited Cyprus and Asia Minor for the Colonial Office, his Reports being presented to Parliament and published ; in 1910 and again in 1913 he visited Ceylon at the request of the Colonial Government and in the latter year and in 1914 also visited India and Newfoundland. He was a member of Government Committees on Oil-seeds, 1915–16, on Mineral Resources, 1917, and on Empire Cotton Growing, 1917. He is President of the International Association for Tropical Agriculture and was President of the International Congress of Tropical Agriculture held in London in 1914.

Professor Dunstan has also occupied an eminent position in the scientific world. He was Secretary of the Chemical Society from 1893 to 1903, and Vice-President from 1904 to 1906 ; in 1906 he was President of the Chemical and Agricultural Section of the British Association, and he served on the Council of the Royal Society from 1905 to 1907, and later on the Council of the Royal Geographical Society.

At a meeting of the Executive Council of the Imperial Institute held on December 12, 1923, the following resolution was passed unanimously :

> "That this Council desires to place on record its very high appreciation of the valuable work accomplished by Professor Dunstan during his long tenure

of the post of Director of the Imperial Institute and its great regret that his services should now have terminated."

The following resolution, proposed by Mr. James Richardson, seconded by Mr. W. Lawton Goodman, was carried unanimously by the Advisory Committee on Timbers at a meeting held at the Imperial Institute on November 26, 1923:

"The Imperial Institute Advisory Committee on Timbers, at their meeting on November 26, 1923, learn with great regret of the impending resignation of Professor Wyndham R. Dunstan, C.M.G., F.R.S., from the Directorship of the Imperial Institute in consequence of the reconstruction of the Institute as contemplated by H.M. Government.

"The Committee desire to record their recollection of the energy displayed by Professor Dunstan in establishing the Committee and in organising their work; and also to express their appreciation of the unfailing interest he has taken in the investigations of the Committee, and of the valuable assistance rendered by him in connection therewith."

It was notified in the *London Gazette* of December 31, 1923, that the King had signified his intention of conferring the honour of K.C.M.G. on Professor Dunstan in recognition of his services as Director of the Imperial Institute.

Appointment of Acting Director.—In view of the resignation of Professor Dunstan, the Colonial Office have decided to appoint an Acting Director to carry on the current administrative work of the Institute, and Mr. H. M. Lidderdale, B.A. (Oxon.), Secretary to the Executive Council, has been instructed to undertake the duties of this office.

Cotton Growing in South Africa.—Records of the efforts which have been made in South Africa to establish a cotton-growing industry and reports on the examination at the Imperial Institute of specimens of cotton produced in various parts of the country have been published from time to time in this BULLETIN (1905, **3**, 26; 1907, **5**, 440; 1911, **9**, 14; 1917, **15**, 453; 1918, **16**, 259; 1919, **17**, 268; 1922, **20**, 205).

The possibilities of cotton cultivation in the Union have now been studied on behalf of the Empire Cotton Growing Corporation by G. F. Keatinge, C.I.E., who made a tour in South Africa during the period November 1922–March 1923, and whose report has recently been published by the Corporation.

According to figures furnished by the Department of Agriculture, the production of cotton in the Union of South Africa during the years 1909–22 was as follows (in bales of 500 lb. each): 1909, 62; 1910, 62; 1911, 26; 1912, 64; 1913, 64; 1914, 142; 1915, 430; 1916, 454; 1917, 486; 1918, 566; 1919, 1,488; 1920, 2,188; 1921, 2,338; 1922, 2,700 (estimated). It is probable that the quantity produced in 1923 will amount to 5,000–6,000 bales.

The report deals generally with climatic conditions, soils and irrigation facilities, the present agricultural practice, the labour supply, and the possibility of cotton growing being taken up by the natives. On the whole, it is considered that the existing supply of labour is sufficient for a steady and fairly rapid extension of the cultivation in most localities but that the natives are not likely to undertake the industry on their own account.

The principal insect pests which attack cotton in South Africa are the American boll-worm (*Chloridea obsoleta*), the spiny boll-worm (*Earias insulana*) and the Sudan boll-worm (*Diparopsis castanea*). Fortunately the pink boll-worm (*Gelechia gossypiella*) and the boll-weevil (*Anthonomus grandis*) are not present in the country and strict measures are being enforced to prevent their introduction. Fungoid diseases appear to cause little or no trouble.

A study of the yields of cotton obtainable in different parts of the Union has led to the conclusion that, taking the country as a whole, an average yield of 150–180 lb. of lint per acre may be expected.

Numerous varieties of cotton are being grown in South Africa, including three American Upland types, viz. Bancroft, Griffin and Uganda; Zululand hybrid; Nyasaland Upland; Sea Island; two Egyptian types, viz. Pima and Sakellaridis; and Watts (probably Allen's Long Staple). All these cottons have been grown for many years and ginned at the same ginnery, with the result that the seed has become hopelessly mixed. It is pointed out by Mr. Keatinge that the most urgent need of the South African cotton industry at the present time is competent botanical supervision. By careful selection, the establishment of seed farms and the adoption of measures to ensure the purity of the seed supply, the value of the cotton could be substantially increased.

The principal cotton tracts are considered separately in the report and estimates are given in each case of the present annual extent of cotton cultivation and the possible annual production within twenty years if suitable en-

couragement is afforded. A list of the tracts and the estimated yields are given in the following table:

Name of Tract.	Cotton now grown annually.	Possible annual production within 20 years.
Rustenburg-Waterberg Tract	700 bales	100,000 bales
Spelonken Area	500 acres	20,000 ,,
Tzaneen-Selati Area	600 ,,	10,000 ,,
Acornhoek Area	800 ,,	15,000 ,,
Malelane Area	100 ,,	5,000 ,,
De Kaap Valley	2,000 ,,	6,000 ,,
Nelspruit and White River Settlement	600 ,,	4,000 ,,
Swaziland	1,000 ,,	30,000 ,,
Lobombo Flats	600 ,,	50,000 ,,
Vryheid District, Natal	3,500 ,,	15,000 ,,
Other parts of Natal (Tugela Valley, etc)	1,500 ,,	5,000 ,,
Zululand	1,500 ,,	30,000 ,,
		290,000 ,,

The possibilities of the East London, Grahamstown, King William's Town Districts and Transkei Territory are also discussed.

The report deals fully with the questions of handling, marketing and financing the cotton crop.

The following recommendations are made. An experiment station should be established in the Transvaal low country to serve the tract covered by the Selati and Nelspruit-Komatipoort railway lines. The staff should include a cotton breeder, a soil specialist and an entomologist. The cotton breeder should study the varieties of cotton now grown and establish a supply of commercially pure seed of the most profitable variety. He should also select or breed pure line strains of outstanding merit. A fully equipped seed farm would be necessary and an organisation for seed distribution. This station would serve the whole of the low country in the Transvaal within the main cotton belt, the northern part of Swaziland, and the northern part of the Libombo flats. Another station for selection and breeding and a seed farm should be established in the Ntambanana-Nkwaleni area. This would also serve the new settlement to be made this year at Hluhluwe and the further areas to be opened up shortly in Zululand.

A strong commercial corporation should be formed for handling, marketing and financing the crop, with the support of the Union Government and the Empire Cotton Growing Corporation, and should commence operations in the Transvaal low country. A ginnery and press should be established at Komatipoort, together with an agency to buy seed-cotton outright or to handle and market cotton for the farmers on commission. The operations of

the corporation might be extended subsequently to other tracts.

Appended to the report are (1) a note on cotton growing in the Transvaal East of the Drakensberg Mountains, submitted to the Union Government in December 1922, and (2) a copy of a letter dated January 1923, addressed by Sir Henry Dundas to the Minister of Agriculture, Union Government, and of reply from the Minister of Lands. A sketch map of the north-east part of the Union of South Africa is provided, showing the areas now devoted to cotton and the potential cotton areas.

Northern Trees in the Southern Hemisphere.—The threatened world shortage in serviceable timber has given rise to a stock-taking of forest resources and potentialities in several countries, and the questions involved are receiving serious attention in the British Empire. The main problem is twofold, namely, the securing of adequate supplies of timber for present needs, concurrently with the adoption of measures which will ensure resources of timber for the requirements of the future. In a country still possessing extensive forests which hitherto have escaped exploitation to a dangerous degree, the solution may be found mainly in conservation of the existing forests based on a carefully regulated system of felling; while in those more numerous countries where the once extensive forests have in large measure been destroyed, interest must centre on measures of afforestation. In these latter countries circumstances call for trees of rapid growth which yield useful merchantable timber, a combination of characters which it is not always easy to secure. In the British Empire, Australia, New Zealand and South Africa stand out as examples of such regions. In these countries extensive forests have in great measure disappeared, and in all three cases there is a large import of timber (chiefly coniferous "softwoods") which it would be to local advantage to produce from home supplies. Considerable work has been done in the experimental planting of selected trees, and it is interesting to note the degree of attention which has been given to exotic species in preference to indigenous trees, which in many cases do not appear to grow at a sufficiently rapid rate.

An admirable critical review of the present position of these experiments in the Dominions mentioned is afforded in a paper by Mr. Ernest H. Wilson, Assistant Director of the Arnold Arboretum, published in the *Journal of the Arnold Arboretum* under the title of "Northern Trees in Southern Lands" (1923, vol. iv, pp. 61–90),

of which a copy has been received at the Imperial Institute from the author. The paper gives the results of Mr. Wilson's observations made during his recent tour through Australasia and South Africa, and is one of the most important contributions to the study of Imperial forestry that has appeared in recent years.

The circumstances which have chiefly governed the planting experiments carried out in Australasia and South Africa are that, in the southern hemisphere, there is a scarcity of indigenous coniferous timber—relatively so abundant in northern countries—and that it is precisely this class of timber which is most in demand for general constructional work. It is therefore natural that efforts should have been made to grow in these lands the timber-yielding trees of the northern hemisphere. Before dealing individually with the species concerned Mr. Wilson gives a brief account of existing forest conditions in these southern countries and the problems confronting the forester. The facts are well known and need not be referred to here.

Mr. Wilson remarks that the Scots Pine (*Pinus sylvestris*, L.) and the pines of the colder parts of eastern and north America and of eastern Asia—species making an invaluable contribution to the world's requirements of timber—are found to be worthless in the antipodes ; while his observations show that this disconcerting state of affairs finds a partial compensation in the fact that certain northern species of small value as timber trees in their own country prove to be most promising sources of timber in their new southern homes. A good example of such a tree occurs in the first species dealt with by Mr. Wilson, namely, the Insignis or Monterey pine (*Pinus radiata*, D. Don). The author considers it probable that this species will prove the most valuable northern conifer in the southern countries. In Australia and South Africa it is the most successful conifer yet introduced, growing at a phenomenal rate and yielding abundance of a serviceable timber for general purposes. The tree is not equally thrifty in all districts, and does best in South Australia and Victoria, the Canterbury Plains of South Island, New Zealand, around Cape Town and Grahamstown, and to a less extent in certain areas of North Island, New Zealand, and of Tasmania. It is stated that on good soil a fully stocked wood of *Pinus insignis* at forty years of age is estimated in South Africa to yield from 10,000 to 12,000 cubic feet of timber per acre. The author remarks that where it is found to flourish, no more useful softwood tree can be planted in the southern countries.

Much attention has been given to the Cluster Pine (*Pinus Pinaster*, Ait.). The chief success has been attained in South Africa, especially at Cape Town, Grahamstown and Knysna, and the timber has been found suitable for constructional work, packing-cases, general carpentry and for creosoted sleepers. In Australia and New Zealand this pine does not promise to become an important source of timber.

The Stone or Table pine (*Pinus Pinea*, L.) has been well tried, but, except at Cape Town and Port Elizabeth, where it is successful as an ornamental tree, there is little evidence that this species will become of importance, and the case is the same for the Aleppo Pine (*P. halepensis*, Mill.).

The Canary Islands pine (*P. canariensis*, Smith) does well in both Australia and South Africa and Mr. Wilson considers that in those districts where the rainfall occurs other than in the summer, this handsome tree is the most valuable conifer that can be grown both as a source of timber and for ornamental purposes. It is the most useful pine in Western Australia, and flourishes in South Australia, Victoria, Tasmania, and at the Cape as far eastwards as the rainfall is distributed throughout the year. The timber is of superior quality and is valuable for building and general constructional work.

The Himalayan Chir pine (*Pinus longifolia*, Roxb.) may be regarded as complementary to the Canary Islands pine as regards its rainfall requirements, since it flourishes in districts where a summer rainfall prevails. The tree succeeds in certain districts of South Africa, but very few trees were seen in Australia, though Mr. Wilson considers that this pine should prove of great value in districts comparatively near the sea in southern Queensland, New South Wales and possibly Victoria.

Pinus ponderosa, Dougl., grows rapidly and regenerates well in Victoria and New South Wales, and promising results have been obtained in New Zealand; while in South Africa the possibilities of the species are being carefully studied.

Pinus Laricio, Poir., together with the previous species, ranks next after the Insignis pine as the best pine for New Zealand, but except for special localities in Victoria and New South Wales there would appear to be little prospect of success with this species in Australia.

In addition to the above pines, Mr. Wilson believes that in the coastal districts of New South Wales and southern Queensland such species as *P. palustris*, Mill., *P. tæda*, L., *P. glabra*, Watt, *P. caribæa*, Mor., *P. echinata*,

Mill., and *P. occidentalis*, Swartz, deserve thorough trial. Some of these species were found to be flourishing in certain districts of South Africa, and Mr. Wilson also refers to the enterprise of the South African Forestry Department in introducing Mexican species of Pinus, certain of which already appear likely to do well in the northern and eastern parts of South Africa.

In view of the large imports of British Columbia Douglas fir into the antipodes, much interest attaches to the results of planting experiments which, so far, indicate that the tree should do well in some districts of Australia and in New Zealand. The value of the species as a producer of useful timber, moreover, has yet to be determined, while in South Africa it would appear that there is little hope for Douglas fir as a tree for forest planting.

Much attention has been given to larch in New Zealand, and very encouraging results have been obtained. European Larch (*Larix decidua*, Mill.) is chiefly concerned, but the slower growing Japanese tree (*L. Kaempferi*, Fortune) has also been planted. The author considers that in New Zealand, larch is destined to rank with Insignis pine and *P. Laricio*, Poir., as the most useful northern trees for forest planting; and he suggests also that certain areas of Victoria and New South Wales and Tasmania offer prospects for this tree. Elsewhere in Australia and throughout South Africa larch is not a practical proposition.

The spruces (Picea), firs (Abies) and hemlock (Tsuga) do not appear to offer any prospects of real success either in Australasia or South Africa.

The genus Cupressus appears to do well in both Australasia and South Africa. The Monterey Cypress (*C. macrocarpa*, Hartw.) is the favourite species and succeeds over a wide area, the finest specimens observed being in Tasmania. In forest planting in eastern Australia and South Africa, the Nepal Cypress (*C. torulosa*, D. Don) and the "Portugal" Cypress (*C. lusitanica*, Mill.) promise best. The genus is considered as having a decided future both as timber species and for ornamental planting.

As regards the question of the possibilities of northern hardwoods in the antipodes, it is remarkable that, in contrast with the conifers, very few of the large number of species tried offer any promise of success. The author points out that in both Australia and South Africa the Eucalyptus is the hardwood tree *par excellence*. In New Zealand, however, a few species only do well, but even here they flourish better than any northern hardwood tree. The oaks are a comparative failure as forest trees in

Australasia, though the European oak has been fairly successful in some parts of South Africa. The willow, *Salix babylonica*, L., is considered to be the most flourishing northern tree in north-eastern Australia, fine specimens affording shade and food for stock; and the tree does equally well in South Africa. The White Willow (*S. alba*, L.) and the Crack Willow (*S. fragilis*, L.) are of great importance in New Zealand (South Island) in keeping the rivers within bounds; and it is interesting to note that the common hawthorns of Europe (*Cratægus oxyacantha*, L., and *C. monogyna*, L.) are extensively used for hedges in the same regions.

The South American tree *Schinus molle*, L., has proved of great value for shade purposes in the dry interior regions of both Australia and South Africa; and the London plane (*Platanus acerifolia*, Willd.) has been successfully used for street planting in parts of Australia, New Zealand and South Africa. European and American species of ash do well in Australasia, but birches and beeches do not flourish. In both South Africa and Australasia suitable woods for match splints are much required; various species of poplar have been tried with promising results, *Populus canescens*, Smith, being at present the main source of supplies in South Africa. The camphor tree (*Cinnamomum camphora*, Nees and Eberm.) has been widely planted in southern countries for shade purposes, and although the tree appears to be of little or no value as a source of camphor or for ornamental purposes, the author regards this species as one of the most useful broad-leaf evergreen trees which have been introduced into the southern hemisphere.

Madagascar Timbers.—The Imperial Institute has received from M. Louvel, Inspector of Rivers and Forests, Madagascar, an attractive album containing forty thin hand-specimens of useful Madagascar woods arranged in slip-in mounts permitting the ready examination of the specimens. The album is accompanied by a very useful handbook written by M. Louvel descriptive of the timbers represented, and issued (in equivalent French and English sections) under the title of "Notice sur les Bois de Madagascar à l'usage des Commerçants et des Industriels." This useful combination of samples and descriptive information was prepared for the Committee of the Commercial Fair held at Tananarive in August and September 1923, and no doubt proved of much practical service.

As in many tropical countries, the forests of Madagascar contain a large number of species of trees, but many of

these, although yielding timber of considerable practical merit, occur either in small numbers or so widely scattered as to render their commercial exploitation impracticable. On the other hand, many trees occur in relative abundance and in accessible situations, and their timber can therefore be relied on as being readily obtainable in commercial quantities. It is with these timbers that the album and its handbook are concerned. For convenience, the woods have been divided into three classes, namely, cabinet woods, building timbers and woods accepted for use as railway sleepers on the Madagascar railways. In all cases, the descriptions give the native and scientific names of the tree, and the density of the timber, followed by a short statement as to the relative abundance of the species and the purposes for which the wood is employed or is suitable. Reference may be made to the timbers of outstanding merit. Among the cabinet woods palissander (*Dalbergia Baroni* and *D. ikopensis*) is the most important, and, with varongy (a building timber), is the most serviceable and valuable of Madagascar woods. There are several varieties differing in colour and grain, but the most important are reddish or violet-brown and fine-grained : a paler variety from the eastern mountainous forests is much sought after for railway sleepers. Other interesting cabinet woods are hintsy (*Afzelia bijuga*), a finely veined yellow-brown wood formerly known as "Madagascar teak," and an ebony (*Diospyros Perrieri*) of fine quality obtainable in large sizes.

The principal building timbers include varongy (*Mespilodaphne* spp.), one of the commonest timbers involving three botanical species yielding distinct varieties of straight-grained, light, useful woods ; hazonema (*Weinmannia* sp.), an excellent timber for general building purposes, wagon construction and flooring, but difficult to work ; tavolo (*Ravensara* spp.), probably the commonest timber tree of Madagascar, yielding a soft, fairly strong wood, light in colour ; ambora (*Schrameckia madagascariensis* and *Tambourissa Thouvenotii*), excellent timbers for general carpentry and joinery ; rotra (*Eugenia cuneifolia* and *E. parkeri*), hard brown-red woods serviceable for construction work, wagon building, flooring, etc. ; halomalanga (*Hernandia Voyroni*), a light fine-grained yellow wood with a camphor odour, which has long been exported to India and China for making coffins ; hetatra (*Podocarpus thunbergii*), interesting as being the only conifer in Madagascar and the same botanical species as one of the "yellow woods" of South Africa. Of the railway sleeper woods, the most lasting are palissander

Dalbergia spp.), hazotokana (*Vernonia* sp.), merana *Vernonia Merana*), vivaona (*Dilobeia Thouarsi*), manoka not determined), longotra (not determined) and notalahy *Faucherea* spp.). The average life of sleepers of Madagascar timbers is said to be about fifteen years. A useful list of the chief timber merchants in Madagascar is appended to the handbook.

Hydro-electric Progress in Canada.—Recent memoranda issued by the Water Power Branch of the Canadian Department of the Interior show that great strides are being made in the development of the hydro-electric industry in the Dominion. The power installed throughout Canada increased by 153 per cent. between 1900 and 1920, and in the latter year amounted to 280 h.p. per 1,000 inhabitants ; at the beginning of 1923 this figure had risen to 338. Development has taken place in most Provinces of the Dominion, but particularly in Quebec and Ontario. The present rate of progress may be gauged from the fact that the annual capacity of the water-power installations in Canada was increased in 1922 by 240,000 h.p. and the total developed water-power is now about 3,000,000 h.p. ; over 2,000,000 h.p. being utilised by central stations and nearly 500,000 h.p. by pulp and paper mills.

It is estimated that the total water-power available in the Dominion, on the basis of a 24-hour day at 80 per cent. efficiency, is no less than 18,255,000 h.p. per annum at ordinary minimum flow. Many new schemes for its utilisation are in contemplation, among which may be mentioned a plan for harnessing the full power of the St. Lawrence.

RECENT PROGRESS IN AGRICULTURE AND THE DEVELOPMENT OF NATURAL RESOURCES

In this section of the Bulletin a summary is given of the contents of the more important papers and reports received during the preceding quarter, in so far as these relate to tropical agriculture and the utilisation of the natural resources of the Colonies, India and the Tropics generally. It must be understood that the Imperial Institute accepts no responsibility for the opinions expressed in the papers and reports summarised.

AGRICULTURE

Foodstuffs and Fodders

Tea.—The *Quarterly Journ., Sci. Dept., Indian Tea Assoc.*, part iv, 1922, p. 125, contains an account of experiments, undertaken during the years 1918 to 1921,

to ascertain the extent to which the quantity of nitrogen, phosphoric acid and potash in the leaf of the tea plant can be altered by ordinary manuring. It was found that nitrogenous manures applied at the rate of over 60 lb. of nitrogen per acre increased the proportion of nitrogen in the leaf, but that manures containing up to 75 lb. of potash or phosphates (reckoned as K_2O and P_2O_5 respectively) per acre had no apparent influence on the amount of potash and phosphorus in the leaf. Heavy pruning increased the nitrogen in the leaf and tended also to increase the potash and phosphorus to a slight extent. Good growth is accompanied by a high proportion of nitrogen and a low proportion of potash in the leaf.

Rice.—The results of experiments carried out at Kharara from 1918 to 1922 on the green manuring of rice combined with the application of artificial phosphatic manures are recorded in *Agric. Journ. India* (1923, **18**, 104). *Sesbania aculeata* was employed to provide the green manure, the best results being obtained in conjunction with 2 cwts. of superphosphate of lime per acre. The increase in yield of grain (paddy) due to such manuring was considerable, the manured land yielding 2,470 lb. per acre and the unmanured 1,261 lb.

Maize.—A report of a conference of maize growers and others interested in maize production in Kenya, held at Nairobi in April last, is given in *Farmer's Journ.*, 1923, **5**, No. 17, p. 5; No. 18, p. 10. In opening the conference the Acting Governor emphasised the advantages to the Colony of encouraging trade in a bulk commodity, such as maize, for which there is a steady and practically unlimited demand in the world's markets. A resolution was passed asking the Government to apply the "Agricultural Produce Exports Ordinance of 1921" to the grading of exported maize. Regulations and details of grading recommended by the Conference are given.

Mesquite.—The *Journ. Dept. Agric., Union S. Africa* (1923, **6**, 62) contains a short discussion of the possibilities of the mesquite (*Prosopis juliflora*) as a famine fodder for the Karroo. It is stated that the tree is drought resistant and capable of withstanding temperatures of 120° F. (in the shade) and 22° F. equally well, and that its beans would form a good source of famine fodder for sheep on arid sub-tropical tracts. In the *Agric. Journ. India* (1923, **18**, 144) the same tree is suggested as a useful plant for India. It is pointed out that the value of the tree does not consist in the pods alone. In some parts of Texas and Hawaii

the long flower-spikes which bear an abundance of pollen are the only source of honey for the bee industry. The wood takes a fine polish and is used for furniture and cabinet work.

OILS AND OILSEEDS

Coconuts.—Reference has already been made in this BULLETIN (1920, **18**, 130) to the investigations that are being made with regard to the small leaf moth or purple coconut moth (*Levuana iridescens*), a pest which causes a low yield of fruit in Fiji. Further information on this subject appeared in *Agric. Circ. Fiji* (1922, **3**, 53). The earliest definite reference to the pest was made by Horne in 1878, who found it ravaging the districts of Rewa and Suva. Since that date the small leaf moth has frequently attacked coconut palms in Vitilevu and it has been noticed that it is subject to an epidemic disease, which often destroys it in certain localities. Hitherto, attacks by this moth have been almost entirely confined to Vitilevu, but recently they have spread to some of the islands forming the Ovalau Group. Owing to this extended range of the pest, it is necessary that drastic steps should be taken immediately to exterminate it. This is somewhat facilitated by a habit the moth has of totally destroying the foliage of one tree before passing on to another. Although it was formerly considered impracticable to control the pest artificially by the use of sprays, spraying with an arsenical preparation is now advocated, using a portable power spraying outfit, with a very long hose. Other methods of control consist in destroying all the old, very tall trees and spraying all palms in the neighbourhood of outbreaks until the disease disappears. In districts where the attacks are very severe the destruction of all the palms is recommended.

Coquilho Nuts.—*Attalea funifera*, a Brazilian palm from which piassava fibre is obtained, yields nuts which grow in large clusters sometimes containing as many as 100 nuts. These nuts are like small coconuts in external appearance, but on being broken open, they are seen to be composed of a very thick shell, which is difficult to crack, enclosing from 1 to 3 kernels. The shells are employed in the manufacture of buttons and other small articles, while the kernels have been alleged to yield a high grade oil, capable of making an excellent drier for use in paints and varnishes.

With the object of ascertaining the truth of this claim, a sample of these nuts was examined by the Scientific

Section of the Educational Bureau, Paint Manufacturers' Association, U.S.A. (*Circular* 181, 1923). The results showed that the nuts contained from 2·2 to 6·9 per cent. of kernels, which yielded 65 per cent. of an oil with an iodine value of 14 per cent. and a saponification value of 261. The oil was non-drying and unsuitable for use in paints. These results are similar to those obtained in the case of oil from the nuts of a species of Attalea, received at the Imperial Institute under the name of "Babassu" nuts (this BULLETIN, 1917, **15**, 38).

The demand for coquilho nuts is growing steadily, and the amount exported to Europe is increasing every year.

Oticia or Oiticica Oil.—Oticia kernels from South America have been examined with a view to ascertaining the suitability of their oil for paints and varnishes (*Circular* 177, *Sci. Sect., Educ. Bur., Paint Manuf. Assoc., U.S.A.*, 1923). The kernels were dark brown externally and dark amber-coloured internally. On extraction they yielded 50 per cent. of a rather viscous oil, resembling Tung oil in appearance and odour. A film of the oil dried overnight with a frosted appearance. The acid value was found to be 45·3 ; iodine value 123 and saponification value 203·2. On heating, the oil rapidly became highly viscous, but on continued heating at a high temperature it did not polymerise to a solid mass. This failure to become solid is regarded as possibly due to the acidity of the oil. It is considered that although the iodine value is lower than that of Tung oil, oil produced from fresh oticia kernels would probably have many of the characteristics of Tung oil.

Oticia oil, under the name of oiticica oil, has been previously examined by other investigators. Bolton and Revis (*Anal.* 1918, **43**, 251 ; this BULLETIN, 1918, **16**, 399) stated that the kernels were probably derived from *Couepia grandifolia*, and found the oil to have an iodine value of 179·5 and a saponification value of 188·6. The effect of heating it at 300° C. served to distinguish this oil from Tung oil, oiticica oil polymerising to a transparent jelly, which swelled in linseed oil and chloroform.

Soy Beans.—As a result of the efforts made by the Educational Bureau, Paint Manufacturers' Association, U.S.A., soy beans have become an important oil seed crop in the United States. According to *Circular* 165, 1923, published by the Scientific Section of this Bureau, there are now a number of mills in the country crushing soy beans. Although the quality of the American oil may not in some cases equal the imported oil in certain charac-

teristics, such as the iodine value, yet as regards clearness and acidity it is superior.

Two samples of American soy bean oil, which have recently been examined, showed acid values of 0·6 and 0·7, and iodine values of 119·4 and 120·6 per cent.

FIBRES

Colombian "Pita" Fibre.—An account of an investigation of the "pita" fibre of Colombia has been published in this BULLETIN (1918, **16**, 289). In a subsequent issue (1920, **18**, 543) reference was made to an article by Mr. M. T. Dawe, F.L.S., in which particulars were given of the character, mode of occurrence and habits of the "pita" plant, together with a description of the native methods of harvesting and extracting the fibre. It was stated in this article that the plant is a member of the natural order Bromeliaceæ and had hitherto been regarded as *Ananas macrodontes*, but that the examination at Kew of botanical specimens collected by Mr. Dawe in Colombia had proved it to be distinct from that species.

In the *Kew Bulletin* (1923, No. 7, p. 266) it is stated that further specimens of "pita," including a few flowers, have now been received from the Chiriguana district of Colombia, and these show that the plant is a species of *Bromelia* and is identical with the plant described by André as *Æchmea Magdalenæ*, of which only leaves and young fruit were previously known. The plant has been carefully studied at Kew, a full description of the flowers is given, and the name *Bromelia Magdalenæ* has been assigned to it by C. H. Wright.

Flax.—In the *Journ. Dept. Agric. and Techn. Inst. for Ireland* (1923, **22**, 413) reference is made to a competition of flax-pulling machines held in July 1922, at Wattetot-sous-Beaumont, in the North of France. Three machines took part, viz. (1) the Marshall machine, working by means of combs (see this BULLETIN, 1922, **20**, 210); (2) the Push-Tombyll machine, working by means of rollers and manufactured by the U.S.A. Flax Harvesting Company; and (3) the Zémont machine, working by belts and manufactured by M. Zémont, a French engineer. No definite conclusions could be drawn from these tests, as the conditions at Wattetot were unusual. The flax was very short and with heavy heads and was harvested too early, whilst the plot was overrun with weeds. Observations were made on the machines, however, by a French expert.

Regarding the Marshall machine, it is stated that when the machine has passed, small swaths are left lying

in its track which have to be gathered up by hand, and in this respect the machine is incomplete. It is regarded as particularly suitable for pulling flax which is still green and for work in damp climates and possesses the advantage that all its mechanism clears the ground well.

In the case of the roller machine, in which the pulling is accomplished by two rollers which seize the flax between them, the flax stems have to be gripped as near the ground as possible as otherwise they will lie down in front of the machine and will not be pulled up. This machine is therefore most successful when the flax is well matured and not too heavy in the head. As the pulling is done close to the ground, weeds are pulled up with the flax and reduce the value of the crop. Moreover the flax tends to become entangled in the rollers, with the result that the machine clogs and has to be stopped. The Push-Tombyll machine is really a reaper and binder transformed into a flax-pulling machine, the knife-blade carrier being replaced by the necessary pulling attachment. The crop is guided towards the rollers by a series of rakes which help to carry the flax backwards. The machine, drawn by three horses, can pull from 2½ to 3¾ acres per day, the width pulled at one time being 28 inches. The machine also binds the flax.

In the case of the machine in which the pulling is done by means of belts, the principle is similar to that of the roller machine, the rollers being replaced by belts in such a way as to increase the sphere of action. The working conditions are practically the same and the same remarks apply.

Cotton

Tanganyika.—The following particulars of the production of cotton in the various districts in Tanganyika Territory during the seasons 1921–2 and 1922–3 have been supplied by the Department of Agriculture. It will be observed that there was a slight decrease in the latter season, the total output being equivalent to 7,175 bales of 400 lb. as against 7,327 bales in 1921–2.

District	1921–2 *lb.*	1922–3 *lb.*
Morogoro	1,039,257	848,304
Mwanza (including Shinyanga)	322,080	1,160,685
Rufiji	320,927	269,493
Lindi	798,346	218,032
Bagamoyo	9,389	77,504
Kilwa	92,295	39,796
Dar-es-Salaam	348,694	152,080
Moshi and Lushoto	—	99,192
Pangani	—	4,950
Total	2,930,988	2,870,036

Palestine.—Reference to the possibilities of cotton growing in Palestine is made in a report by Mr. A. D. Southard, formerly American Consul at Jerusalem, which is reprinted in *Commercial Bulletin, Department of Commerce and Industry, Palestine* (1923, **8**, 452). Owing to the scarcity of cotton during the American Civil War, an effort was made to establish cotton growing on a commercial scale on the Plain of Phœnicia, in the Haifa-Acre district, and considerable quantities of the fibre were produced. On American competition being restored, however, it was found that the crop could not be grown sufficiently cheaply in Palestine and commercial production ceased about 1870.

In 1909 an area of about 25 acres was planted in the Jewish colony of Petach Tikvah near Jaffa, and about 90 acres were planted by Jewish colonists in Galilee. In the latter area Egyptian Mitafifi was grown, but although the resulting cotton was of good quality, the experiment was not continued. The yields obtained in these cases amounted to about 282 lb. per acre.

In 1910–12, the German colonists at Sarona and Wilhelma, on the coastal plain in Palestine, attempted to grow cotton without irrigation, but although the crops gave good promise at first they did not yield profitable returns.

It is stated that Egyptian experts regard the soil and climate of the Jordan Valley as ideal for cotton cultivation. No proof of this is yet available, however, and experiments cannot be made on a commercial scale until irrigation facilities have been established.

Turkestan.—Efforts are being made to resuscitate the cotton-growing industry of Turkestan which was temporarily ruined by the recent wars. It is stated in *Russian Information and Review* (January 27, 1923, p. 263) that the area devoted to cotton decreased from 1,560,600 acres in 1916 to 140,400 acres in 1922, whilst the production fell from 250,000 tons in 1916 to between 10,000 and 11,000 tons in 1922 ; the yield per acre diminished from 1,100 lb. per acre to little more than one-third of that amount. In spite of various difficulties, due to the decay of the systems of irrigation, the absence of implements and capital and the prevalence of bandits in the cotton areas, some improvement in the conditions has already been achieved. The Chief Cotton Committee has inspired confidence in the growers by the adoption of measures to encourage the industry, including the supply of seed for planting. The

yield per acre has increased, and by December 15, 1922, nearly 20,000 tons of raw cotton had been supplied to the factories. The Committee has sufficient seed available to plant 364,500 acres in 1923 which is expected to yield over 110,000 tons of raw cotton. Irrigation work is being proceeded with and measures are being taken to protect the crop from damage by pests.

MINERALS

General

Sudan.—In the *Geographical Journal* for May 1923 is reported a lecture by Dr. C. Christy on the Bahr-el-Ghazal Province of the Sudan. The region is largely swamp and grass land, but the southern part is interesting as regards the metallic minerals it contains. The Nile-Congo watershed extends from Lake Albert to Dar Fur, and is part of the rim of the vast Congo Basin. It is largely an ironstone divide having an altitude of about 3,000 ft. Except where occasional granite masses protrude it is a more or less continuous narrow strip of level bush-covered laterite country; in some cases a bare ironstone ridge a few yards in width, in others perhaps two miles wide. Detached portions appear frequently as isolated flat-topped hills composed of the same lateritic material.

The author headed an expedition to undertake mineral exploration for the Nile-Congo Divide Syndicate. The expedition visited the old copper mines at Hofrat el Nahras (a name meaning the place of copper). These have been worked by natives for many years until quite recent times. Copper in the form of discs, rings, and small ingots obtained from this deposit have served for purposes of barter in the markets of Dar Fur and Kordofan. These old workings cover an area of about 300 acres and consist of about 1,000 small shafts, now fallen in for the most part, and several large pits surrounded by extensive dumps. The copper occurs as carbonate in a system of veins and veinlets in a complex of basic and acid dyke rocks of Archæan age. The vein filling is a ferruginous quartz. The expedition sunk shafts and found pyrite and chalcopyrite at a depth of about 100 ft. The main lode proved to be about 50 ft. wide. Exploration revealed several similar deposits along the same strike, extending to a point 45 miles from Hofrat, some of which have been

worked by the natives. In some of the copper ores finely disseminated gold is found, and gold is obtained by panning the material near the remains of numerous earthen smelting furnaces. Large deposits of massive specular iron ore are found in the same region, which have long been worked by the natives. Cassiterite and asbestos were also found, and alluvial gold was discovered in paying quantities in certain rivers and their tributaries. Reef gold was also located. The region generally appears to be highly mineralised, and is being further explored. The deposits discovered may prove important, as they are near the route which must be taken by any southern extension of the Khartoum-El Obeid Railway.

Bentonite

Canada.—An account of the properties and uses of the mineral bentonite has been given in this BULLETIN (1922, **20**, 344). The results of analyses and physical tests carried out by E. A. Thompson and A. Sadler with a number of samples of bentonite from Canada and the United States are published in *Summary Report of Investigations*, 1921, *Mines Branch, Dept. of Mines, Canada*, p. 73. The chemical analyses show that the calculation of a formula is not yet possible; the amounts of the chief constituents, silica and alumina, vary greatly, although those of the minor constituents agree closely. High silica is attended by low alumina, and *vice versa*. The analyses give no definite indications of the origin of bentonite. The physical tests similarly showed great variation. In the water absorption test, the weight of water absorbed by 1 gram of bentonite during 24 hours' contact varied from 1·53 to 4·95 grams. Specific gravities varied from 2·44 to 2·78, and fusion points from 1,150° C. to 1,430° C. It was found that there is no fixed relation between swelling properties and the quantity of combined water present. Although heating to 700° C. destroyed the colloidal property, the bentonite still retained some combined water.

Gold

Southern Rhodesia.—An interim report by B. Lightfoot on the geology of part of the Darwin mineral belt, Southern Rhodesia, has appeared (*Short Report*, No. 15, *Southern Rhodesia Geol. Survey*, 1923). The formation consists of crystalline schists ("Basement Schists" of F. P. Mennell), including greenstones, quartz-sericite schists, banded ironstones (ferruginous quartzites), etc., intruded

by granite and a few dolerite dykes. A mica-schist belt runs along the granite margin of the Umkaradzi Valley, and contains most of the gold mines. The Ruia mine is of low grade; an ore-body 37 ft. wide, at a depth of 50 ft., contains only 3 dwts. of gold per ton. The Honest mine, already described by P. A. Wagner (*Trans. Geol. Soc. South Africa*, 1912, **15**, 130), has been proved to a depth of 200 ft. There was one rich shoot which carried coarse gold. The mine is now abandoned.

The Umkaradzi Valley group is gold-bearing over a great width. Gold is carried in quartz stringers, in weathered mica-schist, which run with the schistosity, across it, and N.E.-S.W. Several pipes were worked in the Mickey mine. The results were disappointing, the shoots being very short or the gold content proving very erratic.

The Chin reef strikes N.W.-S.E. in quartz-porphyry, and has a payable section 450 ft. long. In depth the reef splits up into stringers. The Lion Reef, of the Chin group, is 1 ft. thick, carries galena and can be traced for 4,000 ft. in length. Gold to the value of £37,794 has been extracted from 29,742 tons raised from these two reefs. The mine has not been working since 1916, as there are difficulties as regards transport and water supply.

The total value of the gold raised from the Darwin mineral belt up to the end of 1922 was £119,725 in value, about five-sixths of this output being from the Umkaradzi Valley group (mica-schist) and the Chin group (quartz-porphyry). From 1917 there has been a considerable decrease in output, and in 1922 it was less than £1,000 in value.

Canada.—The auriferous arsenopyrite ores of Hope, Coquihalla Area, British Columbia, are described by R. C. Campbell-Johnston in *Mining Journal*, August 4, 1923, p. 600. The ore-bodies constituting the Mount of the Holy Cross group of claims extend over the surface for a proved distance of five miles, with a depth of at least 5,000 ft. Four parallel veins have been uncovered. One adit has disclosed a wide ore-shoot, 400 ft. in length, carrying 500 ft. of backs. The ore should carry gold of value over $6 per ton. The igneous country rock intrudes an older igneous rock with similar mineralisation. The veins carry pyrite and arsenopyrite, some enargite and free gold. An average of bulk ore packed for shipment gave: gold 1·64 oz, silver 2·10 oz. per ton, metallic arsenic 43·01 per cent.

Australia.—H. S. Whitelaw has recently described the present workings in the Wood's Point goldfield (*Bull.* 48,

Geol. Surv., Victoria, 1923). After more than twenty years' inactivity this goldfield is now attracting attention owing to the developments at the Morning Star mine, where operations were commenced during the war period. The Government of Victoria having advanced the Morning Star Co. some £14,000, a new shaft was sunk to a depth of 600 ft.; the amount borrowed was repaid, and the mine is now perhaps the premier gold producer in the State. In this mine a "floor" of quartz between No. 5 (495 ft.) and No. 6 (595 ft.) levels, known as Whitelaw's reef, is being successfully worked. The reef crosses somewhat obliquely a diorite dyke, intrusive in slate rock, and belongs to the type known as ladder veins. The average thickness of the vein is between 5 and 6 ft. There is a possible 1,000 ft. of dyke northward, and 200 ft. southward to prospect. Three mines in this field have now reached the primary zone, viz. Morning Star (600–800 ft.), New Loch Fyne (630 to 730 ft.), and Victoria A1 (1,352–1,452 ft.).

The Ballarat goldfield, Victoria, is described by W. Baragwanath, Director of the Geological Survey (*Memoir* 14, *Geol. Surv., Victoria,* 1923). Gold to the value of £50,000,000 has been obtained from this field, but nearly all the mines ceased working in 1918, and the production has since been insignificant.

United States.—The gold-bearing veins of the Jarbidge mining district, Nevada, are described by Frank C. Schrader (*Bull.* 741, *U.S. Geol. Survey,* 1923).

The veins, which are about forty in number, are of the quartz-fissure type in old rhyolite (Miocene ?), from 1 to over 30 ft. in width, and sometimes traceable for several miles in length, with outcrops rising in places to 50 ft. above the surface. The group, known as the "west veins," dips east into the Crater Range, and comprises the wider and more valuable veins, as those of the Long Hike and North Star: whilst the group or system known as the "east veins" dips west into the Range, has a more northerly strike, and extends through the "craters" (U-shaped cirques, amphitheatres or basins), for some ten miles. There is a third or subordinate system of cross veins which strike N.E.–S.W.

The economic minerals of the veins are native gold, electrum, argentite, cerargyrite and naumannite (Ag_2Se). The chief gangue minerals are quartz and adularia. Other minerals are apatite, barytes, calcite, chalcedony, etc. Two of the most abundant minerals (secondary) occurring both as gangue and as gouge are halloysite and leverrierite,

white hydrous silicates of aluminium, resembling talc and kaolin. The veins are composed of a characteristically laminated milk-white quartz-adularia gangue, pseudomorphic after calcite. This has a platey and bladed structure in which innumerable contiguous or connecting laminæ or plates and blades are variously arranged ("fish-scale quartz" of the miners). The veins are nearly all oxidised to the depth of the present workings (800 to 900 ft.), although a little primary or sulphide ore, consisting of pyrite, argentite and chalcopyrite, has been found in a few mines.

The gold, generally invisible, occurs as specks in the gangue, associated with argentite or other silver-bearing minerals or hæmatite.

The Jarbidge district is reported to have produced bullion to the end of 1921 valued at about $1,500,000, of which the Long Hike mine is credited with nearly $1,250,000.

A preliminary report by F. L. Ransome on the geology of the Oatman Gold District, Arizona, has been published (*Bull.* 743, *U.S. Geol. Survey*, 1923). All the veins occupy fault fissures, with a general N.W. strike, dip N.E. over 60°, and are up to 50 ft. wide. The country rock consists of Tertiary volcanic flows of andesite (principally), trachyte, latite and intrusive porphyry. The veins consist of quartz, calcite and adularia, associated in the ore-shoots with free gold, which is rarely visible. Sulphides are absent from the typical Oatman ores, although the country rock near the veins may contain finely disseminated pyrite. Fluorspar occurs in some veins. The gangue usually contains both quartz and calcite, but if entirely of quartz or calcite, the veins are either low in grade or barren. The larger veins are essentially stringer-lodes of very complex structure. There may be present two or more veins or bands of ore together with many irregular stringers and a considerable proportion of more or less andesitic country rock. Some of the veins show a distinctly banded structure. Usually the sequence has been: fine-grained white quartz; gold-bearing quartz with some calcite and adularia; calcite; but some of the calcite has certainly been replaced by granular quartz. The ore varies in value from $7 to $35 a ton. The Tom Reed vein, by far the most productive in the district, yielded to the end of 1921 gold to the value of nearly $20,000,000. A normal fault, known as the Mallery fault, striking nearly parallel with the vein, but dipping S.W. 60°–70°, has thrown the upper part of the vein down 400 ft. to the S.W. The

Gold Road vein, N.E. of the Tom Reed vein, has also been a large producer. The lode is a sheeted zone, 100 ft. or more in total width, consisting of two main, nearly parallel veins, accompanied by many smaller stringers. The vein is beautifully banded in cross section, consisting of thin layers of fine-grained flinty or chalcedonic quartz —the colours ranging from white, pale yellow, green or buff to dark brown. There are two main ore-shoots, the ore averaging about $9 per ton.

Ransome is of opinion that the Oatman district does not hold out inducements for extensive explorations at depths greater than about 1,500 ft. It is probable that additional ore-bodies remain to be discovered at moderate depths.

Iron

Union of South Africa.—In *South African Journal of Industries* for April 1923 P. A. Wagner describes some deposits of iron ore at Syferfontein in the Rustenburg district of the Western Transvaal. The district is traversed by the Krugersdorp-Mafeking Railway, on which are two sidings about 1½ and 2 miles respectively from the iron-ore outcrops.

The deposits occupy the gentle northern slopes of a wide flat-bottomed valley lying between ridges formed of the Timsball Hill and Daspoort quartzites.

Two main varieties of ore may be distinguished: a hard compact black variety which is the rich ore, and a lower-grade, softer, blackish-grey variety. The iron minerals of the richer ore consist of magnetite in small glistening octahedra distributed through a dull-looking black base composed mainly of specularite. The mica constituent contains vanadium, and appears to be roscoelite. Magnetite is quite subordinate in the softer and poorer ore, the bulk of which is made up of small flakes and crystals of specularite, generally accompanied by much sericite. This deposit is covered by the remains of ancient workings, and it is roughly estimated that over 50,000 tons of ore were formerly taken out, apparently by the use of iron gads and stone hammers. The richest part of the deposit is on farm Syferfontein, No. 963, where the ironstone caps a low ridge. A section through this shows at one point a total thickness of ore of 14 ft. 6 in., averaging 50·2 per cent. of iron; 11·71 per cent. of silica; 0·0118 per cent. of phosphorus; and 0·004 per cent. of sulphur. This particular deposit is estimated to contain over 500,000 tons of ore with probably over 50 per cent. of iron, and less than 11 per cent. of silica. Conditions for cheap mining

are favourable as the ore can be obtained by open cuts and adits.

Petroleum

United Kingdom.—The systematic search for oil in Great Britain, which was commenced in 1918, has already been referred to in the Imperial Institute Monograph, *Petroleum* (1921, pp. 15, 16). A paper by H. P. W. Giffard, recently published (*Trans. Min. Inst. Scotland*, 1923, **44**, 31–57), gives full details of the geological structure observed in the drilling of the 11 trial boreholes—7 in Derbyshire, 2 in N. Staffordshire, and 2 in Scotland—and of the results obtained.

The Derbyshire wells, from north to south, are: (1) Ridgeway, on an anticline trending N.W.-S.E., just south of Sheffield, which passed through the Coal Measures, Millstone Grit, Limestone Shales (Yoredale beds), and Carboniferous Limestone. A strong flow of salt-water was met with at 2,898 ft. (limestone); total depth reached, 2,996 ft. (2) Renishaw, on the eastern flank of the same anticline as (1). Considerable flows of gas were met with in the Coal Measures at 1,600 ft., and salt water and gas at 3,198 ft. (Millstone Grit). The hole reached 4,235 ft., the Carboniferous Limestone having been penetrated 135 ft. (3) Brimington, on the apex of a symmetrical anticlinal fold with a capping of Coal Measures undisturbed by faults. The total depth reached was 4,040 ft., when much water was encountered, after drilling through 1,040 ft. of limestone. A trace of oil was noticed near the top of the Millstone Grit, and a large amount of anhydrite was discovered between 3,665 and 3,783 ft. (4) Heath, on the same general anticlinal structure as Hardstoft, and completed at 4,000 ft. A considerable amount of gas was struck at 1,875 and 2,615 ft. (Coal Measures), salt water at 2,850 ft. (Millstone Grit), and a little oil at 3,942 ft., and a trace of oil at 3,988 ft. (limestone). (5) Hardstoft; the oil was struck in a porous bed, about 2 ft. thick, at the top of the Carboniferous Limestone, and at a depth of 3,075 ft. The total depth is 3,130 ft., and the total production from May 27, 1919, to March 26, 1923, amounted to 1,088 tons. The oil is of very high quality, and similar in character to Pennsylvanian crude. (6) Ironville No. 2; this is on a well-marked dome structure, and was stopped at 4,006 ft., after penetrating 1,000 ft. of limestone. Traces of oil were met with at 1,800 ft., 2,640 ft., and 3,029, a little gas at 1,880, and water at 3,478. (7) Ironville No. 1 is on the same dome structure as (6). A show of heavy oil occurred at 2,031 ft. (Hardstoft oil horizon), but there was

no sustained flow. Water with sulphuretted hydrogen was met with in quantity at 2,405 ft. Limestone was penetrated for 1,600 ft.; and traces of oil were encountered at 2,500 and 3,604 ft., and much salt water at 3,500 ft. The well was abandoned at 3,655 ft.

In Staffordshire, the Apedale and Werrington wells were on an anticlinal structure, and were drilled to 4,248 and 2,670 ft. respectively, but no indications of oil were met with.

In Scotland, the bore-hole at West Calder is on the crest of an anticline in the Oil Shale group (Calciferous Sandstone Series of the Lower Carboniferous), and was completed to 3,918 ft. Traces of oil were met with at 640 ft. (Barracks Limestone), 850 ft., 1,128 ft. (sandstones), and 2,598 ft. (dark shale). The D'Arcy well, which is on a well-defined dome structure, has already been described in this BULLETIN (1922, **20**, 254). The strata at the surface represent the lower portion of the Carboniferous Limestone Series of Scotland. Traces of oil were met with at 493 ft., 615 ft. (light clayey shales), and 1,490 ft. (Marine shales). Much gas was struck at 724 ft., salt water at 1,665 and oil at 1,810 ft., which from July 22 to September 16, 1922, yielded about 7 tons of oil. After the latter date, operations were suspended, the total depth being 1,820 ft. The oil contains 15·13 per cent. by volume of motor-spirit and heavy naphtha, 25·44 per cent. of kerosene and light gas oil, 17·57 per cent. of gas oil, 15 per cent. of lubricating oils and 12·36 per cent. of paraffin wax.

Giffard considers that the Hardstoft production of 7 barrels per day, natural flow, compares favourably with many wells in the United States, and concludes that "the remarkably high quality of the oil and the sustained production are encouraging factors, and it is to be hoped that further test-wells will be drilled in the neighbourhood, with a view to ascertain the extent of the oil-bearing formation. In Scotland the presence of gas and the discovery of a good show of high-grade oil at D'Arcy are promising indications, and there is scope for further exploratory drilling in the neighbourhood."

Italy.—The petroleum deposits of Northern Italy have been discussed by Prof. Gignoux (*Les Matières Grasses*, July 15, 1923, 6494). The Emilia zone, lying on the northern slope of the Apennines, and the only one that has been exploited to any extent, is referred to in the Imperial Institute monograph, *Petroleum* (1921, p. 49). The annual production of this field is from 4,000 to 6,000 metric tons. Gignoux divides the deposit into two groups:

the internal or southern zones, which include the deposits of Montechino, Velleia and Vallezza ; and the external or northern zones, comprising the deposits of Ozzano and Rivanazzano. The petroleum deposits of the southern zones are confined to calcareous breccias occurring in dark argillaceous marls (scaly clay formation). The oil is very light (S.G. 0·72 to 0·78), and can be used directly as a motor-oil. It appears to have undergone natural refining due, probably, to filtration through beds of clay. The petroleum of the northern zones is heavy (S.G. 0·806 to 0·914), and occurs in sandy beds at Rivanazzano (Miocene) and Ozzano (Pliocene).

The mother-rock of the petroleum of the southern zone is probably the scaly clay formation itself. That of the northern zone may be the grits or sandstone of the Miocene and Pliocene, or the petroleum may possibly have migrated from the older scaly clay formation.

Costa Rica.—Arthur H. Redfield writes on the petroleum possibilities of Costa Rica (*Econ. Geol.*, 1923, **18**, 354). The best known oil seep is located on Uscari Creek, west of the town of Suretka. The oil reaches the surface along a fault-plane cutting an outcrop of bluish-grey sandy shale, over 1,000 ft. thick. The oil, which is dark green, and with sp. gr. 0·8861, issues at the rate of 4 to 6 quarts a day. Scattered seeps yielding small amounts of oil are said to occur. The area to be considered favourably must be restricted to a relatively narrow zone between the mountains and the sea. Four important concessions, covering Government lands, have been granted in Costa Rica. Several wells have been drilled, in one instance to a depth of 3,800 ft., without finding oil in commercial quantities. Boring elsewhere is still in progress.

Honduras.—Redfield also writes on the petroleum possibilities of Honduras (*Econ. Geol.*, 1923, **18**, 474). At Guare the oil-bearing rock outcrops for two miles in a gulch, and contains numerous pockets of paraffin-base petroleum. There are also said to be strata impregnated with ozokerite. Other indications are said to occur along Rio Aguan, and a remarkably pure asphalt is reported to occur near Juticalpa, department of Olancho, which is probably identical with the gilsonite deposit on the right bank of Rio Pinal. There are several veins from 2 to 8 in. thick, separated by partings of sandstone, and a few vertical veins 3 in. in width. Several concessions have been granted by the Government. In 1920, two wells were drilled near Omoo. Gas was reported, but no oil. Drilling was begun in April 1921

by the Anglo-Persian Co., in the suburb of Calona, municipality of Juticalpa; but no report of the results of the drilling has been published.

Phosphate Rock

Pacific Islands.—A very full description of the well-known deposits of phosphate rock on Ocean Island and references to deposits on other Pacific islands are contributed by L. Owen to the *Quarterly Journ. Geol. Soc.* (1923, **79**, 1). It is shown that the deposits originated by the metasomatic action of solutions leached from accumulations of guano upon islands of dolomitised coral. The deposits consist chiefly of tricalcium phosphate, with small amounts of calcium carbonate and fluoride, and silica. The variations in the percentage of tricalcium phosphate are remarkably regular, and support the geological evidence that the island has been subjected to a tilting movement about a W.S.W. and E.N.E. axis towards the S.S.E., in comparatively recent times, which is apparently still continuing.

Silica

Canada.—*Publication* No. 555, *Mines Branch, Canadian Dept. of Mines*, 1923, by L. H. Cole, is devoted to the occurrence, exploitation, and uses of silica with special reference to Eastern Canada.

The investigations of which this publication is the outcome have shown that there are in Eastern Canada a number of deposits of vein quartz, quartzites, sandstones, natural sands, flint and diatomite which are capable of commercial utilisation. Up to the present, however, very few of them are being exploited; in fact fully two-thirds of the silica consumed in Canada is imported.

All the economically useful varieties of silica are dealt with; a feature of the work is the chapter on the industrial uses to which each variety may be put, and, in most cases, particulars are given of the requirements of the industries concerned.

In addition to a detailed description, accompanied by maps, of the various deposits in Eastern Canada, the results of chemical and mechanical analyses of samples collected in the field are appended, together with results of some preliminary technical trials.

Silver

United States.—The silver-lead deposits of Creede District, Mineral County, Colorado, are described by

W. H. Emmons and E. S. Larsen (*Bull.* 718, *U.S. Geol. Survey*, 1923). The ore deposits consist of silver-lead fissure veins in rhyolite (Miocene), and fractured zones of silver ore in shattered rhyolite. Faulting has taken place on a large scale, and the veins occupy strong fault fissures. The ore minerals include blende, argentiferous galena, gold, pyrite, chalcopyrite, and their alteration products. The gangue minerals are quartz (much of which is amethystine), chlorite, barytes and fluorspar. Locally the gangue contains much thuringite, an iron-rich chlorite, and near the Amethyst vein adularia has been noted in veinlets cutting rhyolite.

In the fractured zones, the fractures and joint-planes of the rhyolite are filled with thin veinlets of chrysoprase together with green copper minerals, and locally carry very high percentages of silver. Argentite, cerargyrite and native silver are plastered on the walls of the thin, narrow cracks. Iron sulphides are not abundant. Deeper exploration has not exposed corresponding bodies of sulphide ores.

The Solomon-Ridge vein, of the fissure vein class, strikes N. 10° W.; the Amethyst, N. 23° W.; and the Alpha-Corsair, N. 32° W. These three veins with their associated subordinate fissures have produced over 99 per cent. of the ore of the district. In the lower levels silver is present in galena, blende and pyrite, and in quartz stained dark grey by thinly disseminated sulphides.

The silver contents of the shipping ore ranges from 20 to 70 oz. per ton; lead, from 1 to 5 per cent.; the gold content varies, but in several mines it is from 0·03 to 0·25 oz. per ton. The average value of the Creede ores is probably about $28 a ton. The average content of the rich ores of the upper part of the lode is about 50 oz. silver per ton.

From 1889 to 1920, Mineral County produced 44,038,801 oz. of silver; lode gold, $2,715,113 in value; 268,679 lb. of copper; 197,429,511 lb. of lead, and 27,572,407 lb. of zinc, most of which was won in the Creede district.

Tin

Nigeria.—A brief abstract of *Bulletin* No. 1, 1921, *Geological Survey, Nigeria*, by J. D. Falconer, dealing with the geology of the Plateau tinfields, was published in this BULLETIN (1921, **19**, 427). *Bulletin* No. 4 (1923), by J. D. Falconer and C. Raeburn, with notes by A. D. N. Bain and W. Russ, treats of the northern tinfields of Bauchi Province. The country described comprises an area of

about 5,000 square miles, lying to the N. and N.E. of the Bauchi Plateau and including the whole of the N.W. corner of Bauchi Province and some adjoining portions of Kano Province.

The Jere and Sanga Hills are mainly composed of the younger granite, which yields a tin-bearing wash. The Shokobo and Saiya hills largely consist of rhyolite and quartz-porphyry, which are intrusions older than the younger granite. Tinstone occurs in the granite, and also in the rhyolite and quartz-porphyry near granite outcrops, Alluvial tin deposits are found in the neighbourhood of the Saiya Hill. Tin-bearing wash is also found on the Rishi Hill, N.N.E. of Saiya Hill. Cassiterite is abundantly distributed throughout the altered younger granite of the Tongolo Hills, and possibly scattered pockets of this type may have been the source of the tinstone now concentrated along the stream lines. The Kwandonkaya Hills everywhere yield a topaz and tin-bearing wash. The Tibchi and Yeli Hills consist of younger granite, rhyolite and quartz-porphyry. The granite has been greisenised along joint planes, the felspar has been replaced by quartz, topaz and biotite and quartz veins and stringers are common, frequently carrying tinstone. No payable lodes have yet been located, but all the streams leaving the granite carry tinstone in greater or less abundance, and most of them are now being exploited.

The older granites and gneisses are not themselves tin-bearing, but where they have been invaded by masses of younger granite they have been much fractured and broken near the contact, and, in places, altered and mineralised. In this field there is a complete absence of tourmaline from the younger granite and its emanations.

Tin mining is mainly confined to the working of high and low terraces and stream bed deposits along the present river lines. Ancient alluvial deposits occur at Dower, in the Rishi gap, and between Rinjim Gani and Magumma. High-level terraces usually carry little or no tinstone, but one at Maflumba on the Kuskerri River is exceptionally rich in cassiterite. The low terraces and valley flats in the neighbourhood of the present stream lines usually carry tin-bearing wash in old channels in the bottom, but the concentrate varies in quality according to distance from granite outcrops or from local " feeds."

In the lower reaches of the Ningi River, in the N.W. corner of Bauchi Province, low terrace deposits, consisting of a coarse wash of rounded granite and porphyry pebbles, lying on bedrock, contain a fair amount of tinstone.

The younger granite of the Kila and Wurji Hills, N.E.

of the Ningi Hills, is characterised by riebeckite (soda hornblende), which replaces biotite. In this field such granite carries little or no cassiterite.

NOTICES OF RECENT LITERATURE

MALAYA: THE STRAITS SETTLEMENTS AND THE FEDERATED AND UNFEDERATED MALAY STATES. Edited by R. O. Winstedt, M.A., D.Litt. Pp. xi + 283, 8vo, 9 × 5¾. (London: Constable & Co., Ltd., 1923.) Price 12*s.*

This volume, edited and largely written by an officer of the Malayan Civil Service, gives an attractive account of the Malay Peninsula, its history, climate, scenery, minerals, fauna and flora, agriculture and industries, and other matters of interest, together with information on the language, literature, religion and characteristics of the Malays and other races inhabiting the country. Several of the chapters are contributed by technical officers of the Government, and the editor makes it evident in his preface that the work as a whole may be regarded as an authoritative treatise on the Peninsula. Excellent illustrations, statistical tables, diagrams and a map enhance the utility and interest of the volume, which should have a large number of readers in technical and administrative circles as well as among the general public.

EQUATORIA: THE LADO ENCLAVE. By Major C. H. Stigand, O.B.E. With Preface and Introductory Memoir by General Sir Reginald Wingate, Bt., G.C.B., etc. Pp. lv + 253, 8vo, 8¾ × 5½. (London: Constable & Co., Ltd., 1923.) Price 21*s.*

In this posthumously published work we have a comprehensive account of the history, physical geography and ethnology of the district under consideration.

A considerable portion of the book treats of the various districts in detail. This is the least readable part on account of the endless succession of names due inevitably to the multiplicity of tribes, sub-tribes, languages and dialects to be described. The position of the languages is considered in a separate chapter which would have more interest for the philologist than for the general reader.

The most interesting chapters are those dealing with the people and their customs generally, with the Nile and the Upper Rift Valley, with Emin Pasha, and with the future of the Enclave. With respect to the last, the

author concludes that the most that can be hoped for is that the district will just pay its way.

An appendix contains the Articles of the Agreement of 1894 between Great Britain and Leopold II relative to the Enclave.

The book is supplied with a chronological table of principal events, and possesses several maps, but the lack of illustrations is to be regretted. There is an extensive bibliography.

The introductory memoir by General Sir Reginald Wingate is by no means the least interesting part of the book.

THE FORESTS OF INDIA. By E. P. Stebbing, M.A. Vol. II. Pp. xii + 633, 8vo, 8¾ × 5¾. (London: John Lane, The Bodley Head, Ltd., 1923.) Price 42*s*.

The first volume of Professor Stebbing's work was reviewed in this BULLETIN (1922, **20**, 419), where the general lines on which he has planned his treatise were indicated and attention drawn to its authoritative nature. It may be confidently stated that those who have perused the earlier volume will not be disappointed with the second, and that they will look forward to the appearance of the third volume, for which it has been found necessary to arrange on account of the great mass of material placed at the disposal of Professor Stebbing from official sources, and his desire to make adequate use of it. The present volume brings the history of Indian forestry down to the year 1900; it is proposed in the third volume to deal further with a portion of the period now considered and to add an account of the progress made from 1901 to 1920.

Like the previous volume the book will repay careful study by all who are concerned with forestry, not only in India but in all parts of the Empire.

THE FLORA OF THE MALAY PENINSULA. By Henry N. Ridley, C.M.G., F.R.S., F.L.S., late Director of Gardens and Forests, Straits Settlements; with illustrations by J. Hutchinson, F.L.S. Vol. I, Polypetalæ. Pp. xxxv + 918, 8vo, 8¾ × 5¾. Vol. II, Gamopetalæ. Pp. vi + 672, 8vo, 8¾ × 5¾. Published under the authority of the Government of the Straits Settlements. (London: L. Reeve and Co., Ltd., 6, Henrietta Street, Covent Garden, 1922 and 1923.)

In building up knowledge of a country, especially in the early stages of its development, there are few more important desiderata either from the point of view of

pure science or practical utility than a local flora. The appearance of Mr. Ridley's work (of which two volumes have been published) is particularly welcome, since there will now be available an authoritative handbook of the known flora of one of the most interesting botanical regions of the world, embodying the observations of the large number of famous botanists, including the author himself, who have travelled and collected therein. The record of species is a heavy one, but it must be remembered that comparatively little of the peninsula has been explored botanically, and much of the record is based upon the results of short collecting expeditions. Space does not permit reference at any length to the special botanical interest of the region dealt with in the work, but as mentioned by the author in his introduction, the area of the Malay Peninsula, as referred to in this flora, falls into two natural divisions with wide variations as regards climate, soil and flora. In the northern portion, with usually a sandy soil and a regular dry season, the plants are mainly herbs and low shrubs with very few trees of great size. The southern region, however, is or was one continuous area of typical dense rain forest of large trees, many over 150 ft. high, in a country where rain falls every day.

In the nothern area there are represented over forty genera not occurring in the southern region, while the latter possesses no fewer than upwards of sixty well-represented genera that are not found in the north. Throughout the region the number of endemic species is exceptionally large (about half the species recorded), but it is pointed out that further exploration of adjacent countries will probably reduce the number considerably.

The provisional plan of Mr. Ridley's work contemplates five volumes. Of the two now available, Vol. I contains the introduction and Polypetalæ (Ranunculaceæ to Cornaceæ); and Vol. II includes Gamopetalæ (Caprifoliaceæ to Labiatæ). The work is excellently printed and produced, while Mr. Hutchinson's clear line illustrations are most pleasing.

BOTANY: PRINCIPLES AND PROBLEMS. By Edmund W. Sinnott. Pp. xix + 385, 8vo, 9¼ × 6¼. (New York and London: McGraw-Hill Book Company, Inc., 1923.) Price 15s.

While the stream of new textbooks on botany is on some grounds to be deprecated, it must be admitted that no small proportion of those which have appeared during recent years have performed definite service in the advance-

ment of the scientific teaching of botany as a class subject. In considerable measure the worth of these books to the serious student has been proportional to their freedom from the trammels of an examination syllabus, and to their placing before him at least a reasoned statement, if not a discussion, of the problems as well as the facts of modern botany. The present volume will be welcomed by teachers fortunate in possessing students unsatisfied with—and little attracted by—nominal rolls of inflorescences and tabulated "differences between" dicotyledons and monocotyledons. The author has endeavoured to give a concise account of modern views regarding the essential features of the morphology, physiology and classification of plants, based upon his experience in conducting a course for first-year students. The earlier chapters are concerned with structure and function as exemplified by the seed-plants, an account of the soil and its relationship to plant life forming a useful section. There are suggestive chapters on the plant in relation to its environment, heredity and variation, and evolution, while the last five chapters are concerned with a brief but readable survey of the chief divisions of the plant kingdom. A feature of the book, much emphasised by the author, is the abundant "body of problem material" taking the shape of listed questions and subjects for consideration and discussion, arranged chapter by chapter. It is to be hoped that the "college freshmen" for whom the book is intended may find time to devote to these valuable questions which, it is not improbable, may also prove a source of inspiration to examiners. The numerous illustrations (many original and of pleasing freshness) are excellent, and the book is well produced and serviceably bound.

DISEASES OF CROP-PLANTS IN THE LESSER ANTILLES. By William Nowell, D.I.C., Assistant Director of Agriculture, Trinidad and Tobago. With a Foreword by Professor J. Bretland Farmer, F.R.S. Pp. xix + 383, 8vo, 9 × 6½. (Published on behalf of the Imperial Department of Agriculture by the West India Committee.) Price 12*s*. 6*d*.

This volume is one of the most important handbooks on the diseases of tropical field crops that have appeared in recent years. The author has placed his subject on a much wider basis than is usually the case in the ordinary textbook of plant diseases, and, as is pointed out by Professor Farmer in the foreword, the book is essentially a

treatise on the principles of plant pathology with special reference to the diseases met with in the wide range of crops grown in the West Indies. The book was written at the request of the Imperial Commissioner of Agriculture for the West Indies during the author's tenure of the post of Mycologist on the staff of the Department during 1913–20, and has as a primary object the provision of a work of reference to the present state of knowledge regarding plant diseases in the West Indies for the use of agricultural officers and planters; while the need for a local textbook of plant pathology for students at the newly established Imperial College of Tropical Agriculture in Trinidad has also been considered. The book should serve these purposes admirably. The first sections, dealing with the nature and classification of plant diseases, and their causation, form a valuable general introduction to the subject, and are followed by a section dealing with the prevention and control of disease and including a practical chapter on fungicides and their application. The main part of the book deals with specific diseases, and, in compiling this section, the author has been able to draw largely from the researches of previous mycologists of the Imperial Department as well as from his own observations and work. The specific diseases are described systematically and clearly, and measures of control are discussed in each case. A chapter introductory to this section gives an interesting account of the general agricultural conditions obtaining in the islands of the Lesser Antilles. The book contains a list of principal references to literature and is well indexed. The numerous illustrations (chiefly photographs) add to its utility.

Field Crops in South Africa. By H. D. Leppan, B.Sc.A., Professor of Agronomy, Transvaal University College, University of South Africa, and G. J. Bosman, B.Sc.A., Technical Assistant, Union Department of Agriculture. Pp. ix + 358, demy 8vo. (South Africa: Central News Agency, Ltd.; London: Gordon & Gotch, Ltd., 1923.) Price 21*s*. 6*d*. post free.

This, the first volume of the South African Agricultural Series, has been written with a view to providing farmers in the Union, and students and teachers in the various agricultural institutions, with such practical information as is likely to be of use under the extremely diversified climate and peculiar economic conditions that prevail in South Africa. The two short introductory chapters deal with the historical aspect and a general survey of agriculture and crop distribution in South Africa, and are followed

by chapters on soil management and crop rotation. Useful information as to the treatment of "brak," or "alkali" soils as they are sometimes called, is given in the chapter on soil management, for which the authors are indebted to Dr. J. C. Ross. These soils are commonly present in the arid and semi-arid areas of South Africa, and it is pointed out that the provision of efficient drainage affords the only effective and permanent remedy against the accumulation of soluble salts in excessive amounts in the soil, which is the cause of "brak." A chapter is devoted to each of the principal South African crops; the principal summer crops are maize, sorghums, potatoes, lucerne, cowpeas, soy beans, pea-nuts, cotton, tobacco and sugar-cane; and the principal winter crops wheat, oats, barley and rye. In each case a general account of the crop is given followed by detailed practical information from the point of view of South African conditions. The article on tobacco was contributed chiefly by H. W. Taylor, B.Sc. The concluding chapters deal with grasses and millets for animals; root and allied crops; miscellaneous crops such as flax, buckwheat, sunflowers and pumpkins; and minor crops chiefly of leguminous plants. The book concludes with a chapter on dry-land farming and this contains a useful list of plants that have proved serviceable as stock food in arid parts.

The book is largely a compilation and, as will be seen, it treats of a considerable number of subjects. The available local literature is said to be meagre and difficult to obtain, but references to literature are given at the end of each chapter, and a list of standard works is quoted in the preface for the use of those desiring more detailed or more technical information. The authors anticipate that there will be need for revision of the book as more local data are accumulated; in the meantime, however, it should prove of much use to those for whom it has been specially prepared.

THE CULTIVATION OF SUGAR CANE IN JAVA. An Elementary Treatise on the Agriculture of the Sugar Cane *in Java and more especially on its Cultivation on the* Krian Sugar Estate. By R. A. Quintus, Manager, Krian Sugar Factory. Pp. xii + 164, 8vo. (London: Norman Rodger, 1923.) Price 12*s*.

In the preface to this work the author states that, owing to the high cost of land in Java and the official regulations which demand that the land shall not be occupied for more than thirteen months consecutively, the planters in the island have been compelled to practise

very intensive methods of cultivation of the soil, which resemble those adopted in nurseries and botanical gardens rather than the methods ordinarily employed in cultivation on the large scale. Such methods are rendered possible by the abundant supply of cheap labour available. The agricultural practice therefore differs considerably from that obtaining in most other sugar-growing countries, but the principles on which it is based are universal and the information given by Mr. Quintus, though relating particularly to Java conditions, will doubtless be of value to sugar-cane planters in all parts of the world.

The book is divided into two parts, the first dealing with the conditions in Java and the theory of cane cultivation, and the second with the practical methods to be employed.

In the first part, an account is given of the history and distribution of the sugar cane and of the requirements of the plant in relation to soil, climate, irrigation and manures. The morphology, physiology and propagation of the sugar cane plant are described and reference is made to the questions of heredity and selection. The mechanism of the formation of the sugar is discussed, the diseases to which the plant is liable are enumerated, and the subject of yields and the factors on which they depend is fully considered.

The second part deals in detail with the various operations involved in cane cultivation, including tillage, preparation of the planting material, the tending of the plantations, the control of insect pests and other enemies of the plant, and the harvesting and transport of the cane. Information is also supplied with regard to book-keeping, supervision and labour, and cost of production.

The work is well written and profusely illustrated with photographs, charts and diagrams.

THE POTATO, ITS CULTURE, USES, HISTORY, AND CLASSIFICATION. By William Stuart, Horticulturist, U.S. Department of Agriculture. Pp. viii + 518, 8vo, $8\frac{1}{2} \times 5\frac{1}{4}$. (Philadelphia and London: T. B. Lippincott Company, 1923.) Price 12*s.* 6*d.*

This volume is one of the Lippincott College Texts series which is being issued under the general editorship of K. C. Davis, Ph.D. It is specially intended for use in the agricultural colleges of the United States, and although the potato receives consideration as a world crop, the details of cultivation and the varieties grown in countries outside of the United States are not discussed.

The book is divided into two parts: the first deals with

the cultivation, harvesting, marketing, and storage of the potato crop, and the pests and diseases to which it is liable, and concludes with a chapter on the industrial uses of the potato in America and other countries ; the second part treats of the potato from the botanical standpoint and gives a short account of its early history and its subsequent improvement by cross-breeding and selection, concluding with descriptions of the principal commercial varieties. It will be seen, therefore, that the scope of the book is wide and that all phases of the subject have been dealt with. Numerous statistical tables giving information regarding areas, production and yields are included, and each chapter is followed by a table of questions on the text for college use, and a list of references cited.

The work concludes with several appendixes included in which is a useful tabular statement of the chief varieties of commercial potatoes with characteristics, parentage, and references to original descriptions. The book is fully illustrated throughout ; it is well printed and has a good index. For the student it is an admirable textbook, and for all interested in the potato crop it should prove of much value.

Alcoholic Fermentation. By Arthur Harden, Ph.D., D.Sc., F.R.S., Professor of Biochemistry, London University ; Head of the Biochemical Department, Lister Institute. 3rd Edition. Pp. iv + 104, 8vo, 9½ × 6¼. (London : Longmans, Green & Co., 1923.) Price 6*s*. 6*d*.

This work brings together in a clear and connected form the present knowledge regarding the theory of alcoholic fermentation. It deals with the causes which give rise to the fermentation, the chemical changes involved and the mechanism of the process.

The nature of the phenomena on which alcoholic fermentation depends was greatly elucidated by Buchner's discovery in 1897 that it was possible to prepare from yeast a liquid which, in the complete absence of cells, was capable of effecting the resolution of sugar into carbon dioxide and alcohol. Since that time the process has been shown to be of a much more complex character than was then supposed. Buchner's zymase can no longer be regarded as a single enzyme but rather as a collection of enzymes, including carboxylase, a reducase and hexaphosphatase, together with the enzymes which bring about the primary changes in the sugar, and the co-enzyme. The functions of all these bodies are carefully explained in the light of modern researches and indications are given regarding points which still need investigation.

As Dr. Harden states in concluding the historical introduction to the book, " the subject still remains one of the most interesting in the whole field of biological chemistry, the limited degree of insight which has already been gained into the marvellous complexity of the cell lending additional zest to the attempt to penetrate the darkness which shrouds the still hidden mysteries."

The book is written in a very interesting manner and the new edition includes the results of all the most recent work on the subject. An excellent bibliography is appended.

WOOD DISTILLATION. By L. F. Hawley, in charge of Section of Derived Products, Forest Products Laboratory. Pp. 141, 8vo, 9¼ × 6¼. (New York: The Chemical Catalog Company, Inc., 1923.) Price $3.

This volume has been issued as one of a series of "Scientific and Technologic Monographs," which are being produced under the auspices of the American Chemical Society.

The subjects of hardwood distillation and resinous wood distillation are dealt with in Parts I and II of the book respectively. Although this is no doubt the most satisfactory procedure as regards the United States where the distillation of hardwoods and resinous woods form distinct industries, it could not be suitably applied to the wood distillation industry of Sweden as the two branches are so closely related in that country that they could not well be considered apart.

Each of the two parts of the book deals with the chemistry of the raw material, the process of distillation, and the products obtained, and is prefaced by a brief general description of American commercial practice. The subject is treated from a chemical standpoint and only occasionally discusses the engineering problems connected with the industry, but the author considers that nevertheless it is possible that it may afford useful hints to chemical engineers by indicating the results which follow changes in the conditions of operation.

The work has been carefully prepared and is well up-to-date, and will be of special service to chemists interested in the wood distillation industries or in the various products which result from the thermal decomposition of wood.

PERFUMES AND COSMETICS, WITH ESPECIAL REFERENCE TO SYNTHETICS. By William A. Poucher, Ph.C. Pp. xi

+ 462, 8vo, 9 × 6. (London: Chapman and Hall, Ltd., 1923.) Price 21s.

This book is essentially of a practical nature, and deals with most aspects of modern perfumery likely to be of interest to the perfumer without treating in detail of the chemistry of the subject.

The volume is divided into three parts, the first being arranged in the form of a dictionary giving in alphabetical order simple descriptions and uses of the more important natural and synthetic perfume materials, including also pigments, dyes, and other miscellaneous substances employed in the industry. The second part deals with the occurrence of the perfume in the plant and its extraction by all the well-known methods. This is followed by useful information concerning substances used for the fixation of perfumes, concluding with a classified list of those suitable for individual cases. This section of the book also gives recipes for miscellaneous fancy perfumes, and the preparation of toilet waters. The third part deals with cosmetics of various kinds and supplies a large number of recipes. In an appendix useful conversion tables of weights and measures are provided. The book contains a number of excellent photographic reproductions illustrating plants under cultivation, their collection, and methods employed in the extraction of the essential oils.

Scientific Feeding of the Domestic Animals. By Martin Klimmer, Ph.D., D.V.M. Authorised translation from the 3rd Edition by Paul Fischer, B.S.A., D.V.M. Pp. x + 242, 8vo, 9½ × 6¼. (London: Baillière, Tindall & Cox, 1923.) Price 18s.

The book is divided into two sections. The first, dealing with feeding stuffs, gives a general account of their chemical constituents and their conservation and preparation, and also deals with most of the feeding materials likely to be met with in practice. The methods of chemical, microscopical and bacteriological examination of feeding stuffs are outlined, but not at sufficient length to be of much value to the analyst. In this section the descriptions of the individual materials, although concise, contain all the points of practical value in connection with the feeding of animals on scientific lines.

The second section of the book is devoted to the principles of nutrition and feeding, and is based on the epoch-making labours of Kellner, whose tables on the composition, digestibility, and starch value of feeding stuffs are included in the volume. Reference tables of

digestible albumen and starch value ratios, and of feeding standards are also provided. Various rations for horses, cattle and other domestic animals are given, and the feeding of dogs, poultry, fish, rabbits, and geese is also discussed. In following Kellner, who has directed this science into new channels, the author is on safe ground, and the comprehensive and well-ordered treatment of the subject makes the book of sound practical value and easy reference.

GEOMORPHOLOGY OF NEW ZEALAND. Part I: Systematic. An Introduction to the Study of Land Forms. By C. A. Cotton, D.Sc., F.N.Z. Inst., F.G.S. Pp. x + 462, 8vo, 8½ × 5½. (Wellington, N.Z.: Dominion Museum, 1922.)

Dr. Cotton is to be congratulated on producing an interesting book on a fascinating subject. Geomorphology, or the study of land forms, has been dealt with by other writers, but we do not remember seeing any work on the subject in which the arrangement of the matter and the general treatment have been so comprehensive as in Dr. Cotton's work.

The book, while elementary in character, can be read with pleasure and profit by the geologist, while the treatment of the subject is such as to offer no difficulty to the non-technical reader. One can imagine the latter in touring his own and other countries deriving greatly added interest from a perusal of this book, which would enable him to read meanings in every landscape and coast line which otherwise might have been nothing more to him than a mere picture.

The book is copiously illustrated with diagrams and striking photographic reproductions of various land forms. The examples portrayed are taken from New Zealand, and there is perhaps no country in the world more prolific in striking examples of the varied land forms with which the book deals.

THE GEOLOGY OF THE METALLIFEROUS DEPOSITS. By R. H. Rastall, Sc.D., M.Inst.M.M., University Lecturer in Economic Geology, Cambridge, and formerly Fellow of Christ's College. Pp. xii + 508, 8vo, 8¾ × 5¾. (Cambridge at the University Press, 1923.) Price 21*s*.

This work, one of the Cambridge Geological Series, is in two parts, the first portion being devoted to general principles, and the remainder to a description of types of ore-deposits of the various metals. The most interesting

chapters in the first portion of the work are probably those on igneous rocks, metallogenesis and metallogenetic zones.

The examples of ore-deposits given in the second portion of the work are usually typical and well chosen, but it is to be regretted that no example of the silver deposits of Mexico has been included.

The work is on the whole up-to-date, well written and illustrated, and should prove very useful to students of economic geology.

METALS AND THEIR ALLOYS. By Charles Vickers. Pp. xix + 767, 8vo, 9¼ × 6¼. (New York: Henry Carey Baird & Co., Inc., 1923.) Price $7.50.

This volume, which is partly based on the 3rd edition of W. T. Brannt's "Metallic Alloys," has been written by a practical foundryman, primarily "to provide the busy practical man with information sufficiently accurate for his purpose and easy to refer to." As might be anticipated therefore, the work contains but very little reference to the theoretical aspects of the formation and properties of alloys.

The first portion of the book deals very briefly with the occurrence, properties and methods of preparation of all the metals. On the whole the information given is accurate, but occasional errors occur. Thus on p. 79 we are told that the Brazilian deposits of monazite sand are more important than those of India, as they contain a greater percentage of thorium. As a matter of fact the reverse is the case. No mention is made under cerium-copper of the unsatisfactory results recently recorded when using cerium alloys in the manufacture of certain brass castings.

The succeeding chapter deals with the characteristics of alloys and the influence in general on them of certain treatment processes.

After a brief chapter on the art of alloying, the preparation and properties of the more important industrial alloys are considered in detail.

A useful account of the modern method of die-casting is given, whilst other matters dealt with include soft solders and brazing alloys, the composition of miscellaneous alloys, the surface colouring of alloys and the foundry utilisation of waste metals.

The work concludes with a useful glossary of foundry terms.

It is noticeable that although the author mentions by

name many of those who have carried out work on alloys, references to the exact sources of the information are rare.

Mr. Vickers's book will undoubtedly prove of service, not only to the practical man for whom it is particularly intended, but also to those desiring general information on alloys.

POWDERED COAL AS FUEL. By J. T. Dunn, D.Sc., F.I.C. Pp. 23, 8vo, 9¾ × 6. (London: E. & F. N. Spon, Ltd., 1923.) Price 2*s.* 6*d.*

This publication is a reprint of a paper read before the North-East Coast Institution of Engineers and Shipbuilders in Newcastle-on-Tyne on April 6, 1923, and the discussion arising out of it.

While the paper cannot be said to have added appreciably to the information given in Herington's comprehensive book on the subject, which was noticed in this BULLETIN (1921, **19**, 265), it is an excellent review of the progress that has been made in the utilisation of pulverised coal, and will be read with interest by industrial users of coal fuel. The paper gave rise to an interesting discussion of a practical character, and many important points bearing on the practice of burning pulverised coal received attention. The author, in replying to the various points raised, concluded by saying that the particular value of pulverised coal lay in the fact that coals of low calorific value and containing a high percentage of incombustibles could thus be made suitable for industrial use. In this connection one is somewhat surprised to find no mention in the paper of the extensive and successful use in Germany of retorted lignite as a pulverised fuel.

AMERICAN FUELS. By R. F. Bacon, Ph.D., Sc.D., and W. A. Hamor, M.A. 2 volumes. Pp. xv + 1257, 8vo, 9 × 6. (London: McGraw-Hill Book Co., Inc., 1922.) Price 60*s.*

These two volumes deal not so much with the nature and occurrence of American fuels as with their efficient utilisation. They consist of a series of fifteen essays by various experts. The subjects dealt with include the principles of combustion (with a special essay on surface combustion), coke, gasification of coal, low temperature distillation, the various types of gaseous fuel, wood, oil, colloidal fuel and powdered fuel. Probably the last-mentioned essay, which covers over 240 pages, is the most masterly feature of the book. The articles are mostly well illustrated. There are two appendixes, the first being

a reprint of the report of the Joint Committee of the American Chemical Society and the American Society for Testing Materials on methods for the analysis of coal, whilst the second contains methods for testing fuel oils and specifications for these products.

Taken as a whole the work is probably the most up-to-date exposition of current United States practice in fuel technology and will prove of service to all interested in the numerous subjects discussed.

American Petroleum Refining. By H. S. Bell, C.E., etc. Pp. xiv + 456, 8vo, 9½ × 6¼. (London, Bombay and Sydney: Constable & Co., Ltd., 1923.) Price 24*s.*

This book gives a detailed description of the best American practice in petroleum refining. After an account of crude oils and their characteristics, the chemical and physical properties of petroleum are described by T. T. Gray and D. Drogin. An outline is given of the various steps in refining crude oil and this is followed by a discussion of the refining site and general arrangement, and the various types of still, condenser and heat exchanger in use. Cracking and the stills used for cracking are described. In a chapter on chemical treatment, the use of silica gel (a patented product of water-glass treated with certain acids) for the removal of sulphur in oil is mentioned, and a plant for naphtha treatment with silica gel is illustrated. Other chapters deal with wax plants, filtering, cold settling and compounding. Under storage of oil, steel tanks with globe roofs and wooden roofs are shown as well as tanks made of reinforced concrete, and the methods of measuring them are described. The remaining chapters are on bulk transportation, packages, power plant and boiler house, acid recovery, general departments, and fire-protection.

This comprehensive work has 263 illustrations, and should prove indispensable to all interested in this important branch of petroleum technology.

Petroleum Resources of the World. By Valentin R. Garfias. Pp. xi + 243, 8vo, 7½ × 5. (New York: John Wiley & Sons, Inc.; London: Chapman and Hall, Ltd., 1923.) Price 15*s.*

This work briefly describes the petroleum resources of the world, and contains eighteen small-scale maps, showing the producing oil and gas fields, petroleum indications, oil shales, and refineries of the different countries. A map

of the fuel oil bunkering stations of the world forms the frontispiece. The text is, on the whole, commendably brief and accurate, and is written by an oil-geologist who has personally examined a number of the fields described.

Le Mazout. By E. Davin, Mécanicien Principal de la Marine. Pp. 96, small 8vo, 8½ × 5. (Paris: Imprimerie de la Revue "Les Matières Grasses.") Price 2 francs.

Mazout is the French form of the Tartar word *mazouthta*, meaning "grease," and denotes a residue of crude petroleum, after the lighter products have been distilled off. The author deals at some length with the physical and other properties of mazouts or fuel-oils, such as density, flash-point, point of ignition, viscosity, calorific power, and flow in pipe-lines. For the last, Poiseuille's formula, used in the National Physical Laboratory, is recommended for fuel-oils in general.

With regard to colloidal fuel, a translation is given of Lindon W. Bates's paper read before the Society of Arts on November 16, 1920, and we are told that experiments are being conducted for its application in the French Navy.

This little work is well written, and contains a good deal of information about fuel-oils, and should be in the hands of all interested in their production and application.

Oil Power. By Sydney H. North. Pp. 122, 8vo, 7½ × 5. (London: Sir Isaac Pitman & Sons, Ltd.) Price 3*s*.

This little volume is issued as one of Pitman's "Common Commodities and Industries" series.

After briefly describing the sources and production of fuel oil from foreign sources, the author considers home sources. The succeeding chapters deal rather more fully with the use of oil for direct firing, such as on ships and railways, its employment in internal combustion engines and for power and heating generally. The concluding chapters treat of the storage and distribution of oil.

The illustrations include a number of diagrams of oil burners and reproductions of photographs showing oil-firing installations.

The book will serve as a useful introduction to the subject of the utilisation of oil fuel.

Philip's Commercial Map of South America (with handbook). Edited by W. S. Barclay, F.R.G.S. 45 × 70 in. (London: George Philip & Son, Ltd., 1923.) Price,

mounted on cloth and folded in case (or varnished, with roller), 60s.

This map, with its accompanying handbook, has been compiled on the same lines as that of China noticed in the last number of this BULLETIN (1923, **21**, 425), and aims at providing up-to-date and reliable information for business men interested in South American commerce. The map, which is printed in black and seven colours, shows the boundaries not only of the various States, but also of their provinces and departments. Navigable rivers, sea routes, wireless and oiling stations, and submarine cables, are shown; and particular attention has been devoted to the railway systems of the Continent, the different gauges, in view of their bearing on commercial development, being specially indicated. The handbook furnishes well-arranged and copious information on the physical features, climate, topography, language, commerce and industry, and other important features of each of the countries concerned, whilst the index appended to it contains some 6,500 references.

The publication is in every way excellent, and can be recommended not only to commercial houses but to all interested in the recent progress and future development of South America.

BOOKS RECEIVED

AN ILLUSTRATED GUIDE TO THE FEDERATED MALAY STATES. Edited by Cuthbert Woodville Harrison. Pp. 370, 8vo, $6\frac{1}{2} \times 4\frac{1}{2}$. (London: The Malay States Information Agency, 1923.) Price 2*s*. 6*d*.

SUB-TROPICAL AGRICULTURE IN SOUTH AFRICA. By H. G. Mundy, Dip.Agric., F.L.S. Pp. xiv + 328, 8vo, $9\frac{1}{2} \times 6\frac{1}{4}$. (Salisbury, Rhodesia: Argus Printing and Publishing Company, Limited, 1923.)

VEGETABLE CROPS. By Homer C. Thompson, B.Sc. Pp. ix + 478, 8vo, $9\frac{1}{4} \times 6\frac{1}{4}$. (London: McGraw-Hill Publishing Co., Ltd., 1923.) Price 22*s*. 6*d*.

THE LEATHER TRADES' YEAR BOOK, 1923. Edited by Dr. J. Gordon Parker. Pp. 216, 8vo, $9\frac{1}{2} \times 6\frac{1}{4}$. (Published on behalf of the Joint Standing Committee of the United Tanners' Federation, and the Federation of

Curriers, Light Leather Tanners and Dressers, Inc.) Price 6*s*. 6*d*.

THE CHEMISTRY OF RUBBER. By B. D. W. Luff, F.I.C. Pp. 232, 8vo, 10 × 7½. (London: Ernest Benn, Limited, 1923.) Price 25*s*.

AIDE-MÉMOIRE POUR L'INDUSTRIE DU CAOUTCHOUC ET DES MATIÈRES PLASTIQUES À L'USAGE DES INGÉNIEURS, CHIMISTES, PRATICIENS DIRECTEURS ET CONTREMAÎTRES D'USINES. By A.-D. Luttringer. Pp. 225, 8vo, 9 × 5½. (Paris: A. D. Cillard, 1923.)

THE CHEMISTRY OF PAINTS, PIGMENTS AND VARNISHES. By J. Gauld Bearn, M.Sc., A.I.C., F.C.S. Pp. x + 277, 8vo, 10 × 7¾. (London: Ernest Benn, Limited, 1923.) Price 30*s*.

VARNISHES AND THEIR COMPONENTS. By Robert Selby Morrell, M.A., Ph.D., F.I.C. Pp. xii + 361, 8vo, 8½ × 5¾. (London: Henry Frowde and Hodder & Stoughton, 1923.) Price 25*s*.

CARGO HANDLING AT PORTS. A SURVEY OF THE VARIOUS SYSTEMS IN VOGUE, WITH A CONSIDERATION OF THEIR RESPECTIVE MERITS. By Brysson Cunningham, D.Sc., B.E., M.Inst.C.E., F.R.S.E. Pp. ix + 180, 8vo, 8¾ × 5¾. (London: Chapman & Hall, Ltd., 1923.) Price 13*s*. 6*d*.

THE CHEMISTRY AND PHYSICS OF CLAYS AND OTHER CERAMIC MATERIALS. By Alfred B. Searle. Pp. xiii + 695, 8vo, 10 × 8. (London: Ernest Benn, Limited, 1924.) Price 55*s*.

THE MICRO-ORGANISMS OF THE SOIL. By Sir E. John Russell, F.R.S., and Members of the Biological Staff of the Rothamsted Experimental Station. Pp. vii + 188, 8vo, 8¾ × 5¾. (London: Longmans, Green & Co., 1923.) Price 7*s*. 6*d*.

LEAD: ITS OCCURRENCE IN NATURE, THE MODES OF ITS EXTRACTION, ITS PROPERTIES AND USES, WITH SOME ACCOUNT OF ITS PRINCIPAL COMPOUNDS. By J. A. Smythe, Ph.D., D.Sc., Pp. vii + 343, 8vo, 8¾ × 5¾. (London: Longman's, Green & Co., 1923.) Price 16*s*.

SANDS AND CRUSHED ROCKS. By Alfred B. Searle. Vol. I. Their Nature, Properties and Treatment. Pp. xiv + 475; Vol. II. Their Uses in Industry. Pp.

ix + 281, 8vo, 8½ × 5¾. (London: Henry Frowde and Hodder & Stoughton, 1923.) Price 52*s*. 6*d*.

Systematic Survey of Rubber Chemistry. By Clayton W. Bedford and Herbert A. Winkelmann. Pp. 385, 8vo, 9¼ × 6¼. (New York: The Chemical Catalog Company, Inc., 1923.) Price $7.00.

Pulpwood and Wood Pulp in North America. By Royal S. Kellogg. Pp. xii + 273, 8vo, 9¼ × 6¼. (London: McGraw Hill Publishing Co., Ltd., 1923.) Price 20*s*.

Canned Foods in Relation to Health. By William G. Savage, B.Sc., M.D. (Lond.), D.P.H. Pp. vi + 146, 8vo., 8¾ × 5¾. (Cambridge: at the University Press, 1923.) Price 8*s*. 6*d*.

Uses of Waste Materials. The Collection of Waste Materials and Their Uses for Human and Animal Food, in Fertilisers, and in Certain Industries. 1914–22. By Prof. Arturo Bruttini. Pp. xx + 367, 8vo, 9½ × 6¼. (London: P. S. King & Son, Ltd., 1923.) Price 12*s*.

Oil Well Drilling Methods. By Victor Ziegler, A.M., Ph.D. Pp. xii + 257, 8vo, 7½ × 5¼. (New York: John Wiley & Sons, Inc.; London: Chapman and Hall, Ltd., 1923). Price 15*s*.

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Botanical names and titles of books are printed in italics and authors' names in capitals

* The Index to No. 1 (*Report on the Operations of the Imperial Institute*) was issued with that number, pp. i–iv.